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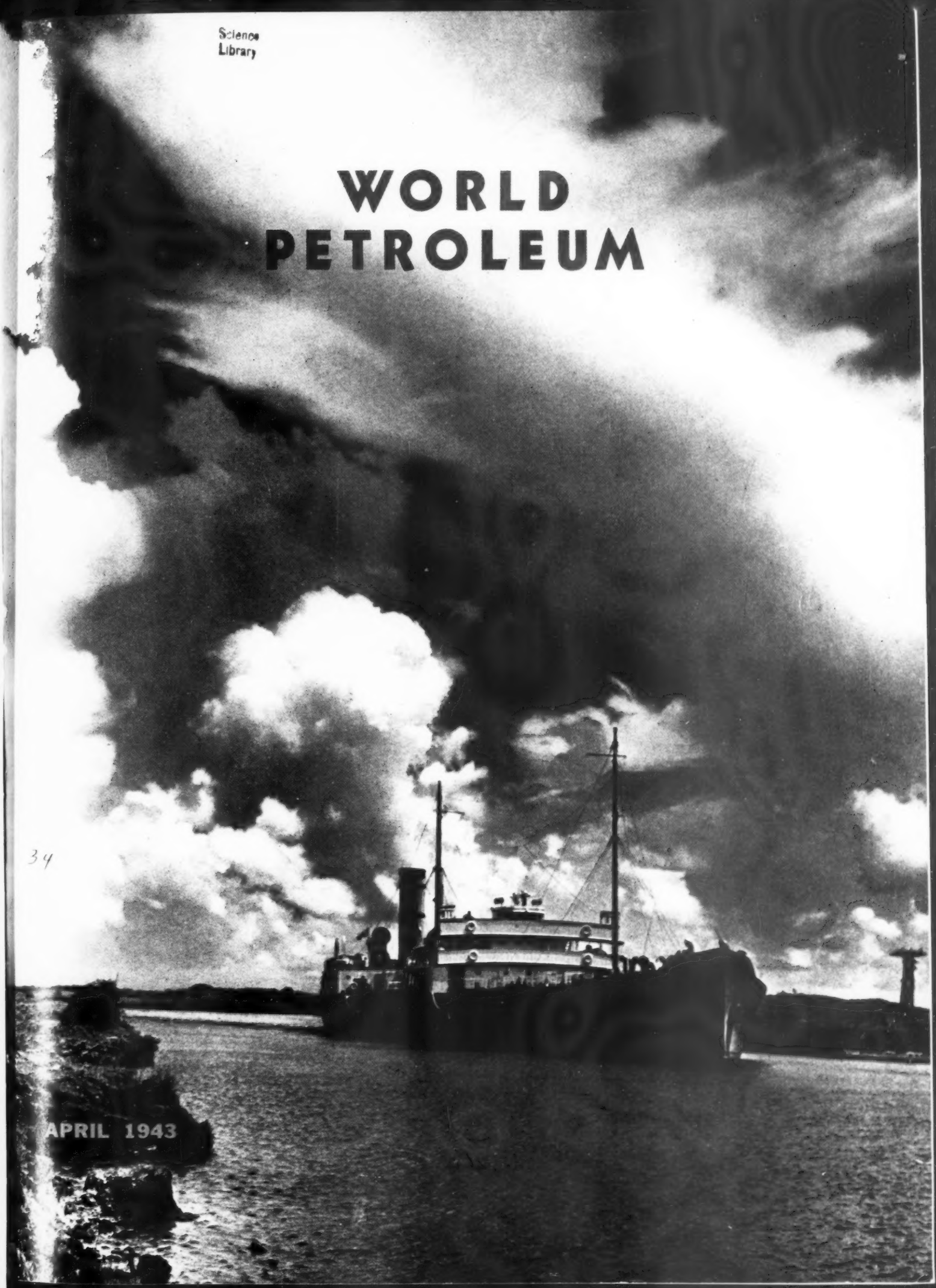

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EDITORIAL

RECASTING THE OIL TRANSPORTATION SYSTEM

TRANSPORTATION has been called the life blood of business, as necessary to the maintenance of industry as is the circulatory system to the health of the human body. Certainly in the case of the petroleum industry this truth has been abundantly, even painfully, demonstrated during the past year. Surplus stocks of gasoline and other products were virtually useless at Gulf Coast points where they accumulated while the activities of millions of persons in the Atlantic Coast area were curbed because these products could not reach them.

From the time when oil began to possess commercial value the progress of the industry has been closely linked with the development of new, efficient and economical facilities of transportation. Wagon trains and primitive types of railway cars moved the first oil produced in Pennsylvania to nearby markets but were too costly a means of conveyance to permit the widespread adoption of the new fuel. Flatboats fitted with small tanks were cheaper but slow of movement and restricted to towns along the river systems. The first long step forward came with the pipe lines, costly to build but inexpensive relatively to operate and capable of delivering a sure and steady supply across the mountains to tide water. Refineries fed by these lines were established in and about coastal cities where ocean vessels could take on products of these plants for distribution to every part of the world.

Then came the era of the tanker, the ship designed especially to carry oil and capable of carrying it in such quantity and at such low cost that no other means of transportation could compete with it. Gradually, as the main sources of petroleum supply moved southwestward to the Mid-Continent and the Gulf Coast the deep water tanker took over the conveyance of oil and its products not only across the oceans but between the Gulf and Atlantic ports. Tankers multiplied in number until they constituted the greatest single division among maritime carriers. Tank cars and pipe lines were pushed into the background except as they were necessary to serve areas that could not be reached over water lanes. Ninety-five percent of all the oil required by the industrial East, the greatest consuming section of the country, reached it via the tanker route.

Pearl Harbor and its aftermath transformed the situation with breathtaking suddenness. Ocean tankers were mustered into war service in rapidly increasing numbers and were assigned to the vital task of supplying fuel to fleets and armies in all quarters of the globe. Within a few months the coastwise tanker movement of oil had fallen to less than a quarter of its volume during 1941 and continued to decrease month by month. The oil industry and the government faced the alternative of witnessing the paralysis of production in the nation's greatest manufacturing district or of finding other means of keeping its wheels turning and its factories operating.

In such a situation there could be only one choice. Working hand in hand and with desperate haste the oil companies, the pipe line operators, the railroad managers and the owners of trucks and barges set out to restore these agencies of transportation not merely to the position they had occupied before the tanker's rise to supremacy but to handle the vastly greater traffic that had developed in the intervening years. Tank cars were gathered from all parts of the country and formed into solid trains despatched on express schedules across half a continent. Pipe lines were reversed in flow, linked together in emergency systems and supplemented by thousands of miles of new construction to send a great river of oil rolling eastward. Trucks and barges were fitted into their appointed places in relieving a situation that threatened to become calamitous.

Under the leadership of Petroleum Administrator Ickes, Deputy Administrator Ralph K. Davies, Chairman Jesse Jones of the Reconstruction Finance Corporation and W. Alton Jones, able chief of the oil industry's transportation activities, the full force of private enterprise and governmental authority has carried this revolution in vital war transport to a successful conclusion. The labors of thousands of men of all stations in life were centered upon the colossal and desperately urgent task. Pipeliners, railroad men, construction workers, engineers and top executives attacked it with enthusiasm stirred by the very difficulties it presented. Ingenuity, skill and experience, backed by long hours of gruelling work, surmounted all obstacles of time, distance and terrain. In the following pages an effort is made to present the broad outlines and salient features of this outstanding development. The accomplishment must long remain an epic of American industry. It stands as one of the great contributions to the effective prosecution of the war. It has been made possible only by heroic toil, the sacrifice of selfish interests and the zealous support of those governmental agencies concerned with petroleum, transportation and war finance.

WARTIME REVOLUTION

In Petroleum Transportation

OF ALL THE REPERCUSSIONS of war that have hit the petroleum industry of the United States during the past two years, none has been more far-reaching than the revolution in transportation which it has made necessary. All branches of the industry have undergone great changes.

The oil producer has been hedged about by increasingly rigid control of his producing and drilling activities, by price ceilings, man-power and materials restrictions. The refiner has been caught in a maze of new necessities by skyrocketing demand for special war materials and by the necessity for shifting a higher percentage of refinery runs from the more profitable to less remunerative products. The petroleum marketer has been pinched into a new and relatively static role, anathema to the competitive spirit that has characterized and stimulated the growth of the entire industry. Every adjustment has been severe.

But in the range of its effect on the petroleum industry, the public, and the unimpeded prosecution of the war at home and abroad, the shift from 95 percent all-ocean to practically 100 percent all-overland transportation of oil to the Eastern seaboard represents the most drastic and fundamental adjustment that the industry as a whole has had to face. This transformation had its origin in the early summer of 1941 when the high command of the United States released to Great Britain some fifty American Flag tankers for the overseas movement of oils destined to the British Isles. The full story behind the sudden transfer of those tankers has yet to be told, but it has not been denied that Britain's need at that moment was more acute than Ministries of Information are wont to reveal. The battle of Britain was hitting high gear, and it may well be that the oil which did not reach Eastern terminals in the United States because those tankers were transferred was the very oil that helped pull England through the tightest phase of the siege.

However that may be, the deepening gravity of the oil transportation situation was highlighted then and there, silhouetted, so to speak, by the lightning flash of war hitting directly at the economic lifelines of America. Progressive difficulties involved in maintaining adequate movements of petroleum and petroleum products to the eastern seaboard soon defined the petroleum problem in drastic detail and the subsequent, temporary return of the borrowed tankers to Gulf-Atlantic Coast service provided only a brief breathing spell in the race to get substitute facilities into volume operation.

Step by step the changed requirements have been met, not sufficiently to meet pre-war demands, plus the expanding scale of war requirements, but more fully than many of those most conversant with the situation dared believe possible. Today it can be said that no fighting plane has failed its mission, no fighting ship has failed to clear on time, no tank nor gun has failed to roll or shoot on command, for lack of oil. That is the pudding's proof, the final capstone for all the credits for war accomplishment that may be passed around to the American oil industry.

The sum of that accomplishment is covered in the pages that follow, but even the summary can scarcely express the scope of the revolution. Shorn of all detail, the problem that faced the transporters of petroleum was this: to move 200,000 tons of oil 1,500 miles daily from Gulf Coast sources to eastern terminals, with facilities, equipment, and personnel never before engaged in such long-distance, large-volume movement of petroleum. Time was short, and perhaps no major development within an established field of industry has ever been started closer to scratch.

The rails offered the most rapidly expansible substitute for the tankers lost to the convoy routes. Necessity set the schedules and fired the boilers of this new movement.

From a daily average delivery of around 4,000 barrels, composed largely of special petroleum products, tank car deliveries rose to more than 100,000 barrels daily by "Pearl Harbor." Meanwhile submarine depredations were taking a mounting toll of the Gulf-Atlantic tanker fleet and continued transfer of bottoms to direct war service whittled deeper into the ocean oil supply line of the eastern seaboard. This critical situation provided continual stimulus to the expansion of the tank car movement. Daily deliveries pyramided throughout 1942 to a peak of 857,000 barrels for the week ended September 19, more than four times the maximum estimate made by railway executives a year earlier. To attain this result, thousands of tank cars were drafted from regional service throughout the country and assigned to East Coast service.

Simultaneously, a combination of strenuous effort within the oil and railway industries backed by PAW orders and rail transport regulations of the ODT, enlarged the number of tank cars in service to the East Coast from approximately 1,000 at the onset of the emergency to approximately 70,000 at the present time. By a process of selection and transfer the average capacity of the tank cars now in petroleum service is about 215 barrels.

The tank car phase of the change in petroleum transportation was and continues to be a costly expedient. At the outset excess costs were borne by the oil companies themselves. Subsequently price adjustments reduced the out-of-pocket drain and currently these costs are compensable by the Defense Supplies Corporation. Nevertheless, it must be recorded that the question of compensation did not cause an instant's delay by the oil companies in accepting the burden of transportation costs regardless of when or how reimbursement might come.

While the rail movement of oil has exceeded all early expectations it was recognized from the beginning that it alone could not fill East Coast requirements and that reorganization and reconstruction of the pipe line system of the country was necessary. The accomplishment that has resulted from the program of pipeline reversal, expansion and construction undertaken jointly by industry units and the Petroleum Administration is an epic story in itself involving operating and financial adjustments of tremendous proportions.

Currently, pipeline runs to Eastern terminals approximate 200,000 barrels daily. With the completion to the East Coast of the 20" War Emergency Products Pipeline, the daily pipeline delivery to the Atlantic Seaboard will, by the early months of 1944, equal fully 50 percent of the prewar demand. Less spectacular in a way but still highly important in their contribution directly and indirectly to the eastward-flowing river of oil are the barge and motor truck services.

It is safe to say that never before has such a far-reaching transition been effected with equal efficiency and speed. It has been made possible only by careful planning, strenuous and unremitting work by men of all ranks and positions, complete cooperation on the part of industry and government and a determined will to keep the war machine rolling and war plants producing at top efficiency.

Transition IN OIL Transportation

By W. Alton Jones

PRIOR TO THE WAR, industries and residents of the East enjoyed plentiful supplies of petroleum products. Gasoline might have been obtained at practically any crossroad in city, town or village. Fuel oil tanks could be filled at will. There was no rationing of civilian supply and but little unsought public attention was directed to the industry which so efficiently placed its products within easy reach of all.

To assure delivery of the required oils to the markets and refineries of the East, the industry had developed and owned an economical and highly efficient transportation system. One of the most important links in this system was a major fleet of ocean tankers plying between the U. S. Gulf, the Caribbean and the Atlantic Seaboard. These ships delivered more than 63 million gallons of crude and refined oils to Eastern ports every 24 hours. Economics confined the eastern movement of petroleum by railroad tank cars to relatively small volumes of special products and the flow of oil in pipeline systems in the East was mainly in a westerly direction, to inland destinations. Such were the conditions prior to the autumn of 1941.

At that time the war clouds of Europe had already begun to cast disquieting shadows on the eastern petroleum picture and their true significance was accurately appraised by the Honorable Harold L. Ickes, Petroleum Administrator for War, and by leaders in the petroleum industry. These men visualized the probable need for large volume overland movement of oil to the Atlantic Seaboard states and had earlier advocated the construction of large diameter pipelines as the most effective substitutes for ocean tankers. Widespread opinion as to the need for these pipeline facilities did not crystalize until after our nation had declared war and valuable time was thus lost before actual construction work was finally authorized.

Fortunately there was in the Office of the Petroleum Administration for War an understanding and aggressive leader who fully realized the industry's position and the magnitude of the problem which it faced. He and his staff have given every possible assistance in effecting the necessary far-reaching changes which have been and are being made in order to increase the flow of oil to the East. During this trying period the industry has also had the realistic assistance of government agencies directed by the Honorable Jesse H. Jones. The highly cooperative attitude which has prevailed between these various government agencies and the petroleum industry has made possible more extensive contributions to the war effort than may be generally realized.

Much progress has been made during the past year in the transition of the eastern transportation system from one of almost all ocean traffic to the present and near term future movements through overland facilities and protected inland waterways. For the purpose of increasing deliveries to the East, carrying capacity of the older pipeline systems has been enlarged; direction of flow has been reversed and other lines converted from products to crude oil service in a combined total of 3,250 miles of pipelines; some 2,300 miles of line have been reclaimed from systems serving less useful purposes in other parts of the country and relocated for eastern service; the first section of the 24-inch pipeline stretching 531 miles from East Texas to Norris City, Illinois, has been completed and placed in operation; construction crews have battled mud, snow and ice in the Pennsylvania mountains during the past winter building the 857 mile extension of the 24-inch line toward New York and Philadelphia to which terminals it will be completed by early summer, and preliminary construction work is now starting on a second "big inch" line, 20 inches in diameter, which is planned to extend from the Gulf Coast to the Eastern Seaboard.

Upon completion of "big inch" lines, the overall program will have seen a total of 4,000 miles of new pipelines built. A further measure of the magnitude of this pipeline program is its cost. As presently constituted, the total will approximate $310,000,000 provided by the petroleum industry and by government.

The conversion of our petroleum transportation system is now well advanced and the completion of projects presently underway is imminent. With a continuance of the remarkable performance recorded by our railway systems, deliveries of oil to the East will continue to increase and by late summer of the current year should be at higher levels than in 1941. While we may look forward with confidence toward a realization of these projections, the warnings of the Petroleum Administrator should be borne in mind. He has frankly informed the public as to anticipated large increases in requirements for the armed forces and has expressed as his considered opinion the very probable necessity for continuance of rationing the civilian supply.

* President, Cities Service Company
President, War Emergency Pipelines, Inc.
Chairman, Committee on Transportation (P.I.W.C.)
Chairman, Temporary Joint Pipeline Managing Subcommittee (P.A.W.)
Chairman, Pipeline Management Committee (P.I.W.C.)
Chairman, Transportation Committee, P.A.W. District No. 1

Mr. Jones pushes the lever that starts the flow of oil eastward from Norris City.

Tank cars lined up at a loading rack at a Gulf Refinery in Texas. Photo courtesy Gulf Oil Company.

TANK CAR MOVEMENT OF OIL

Saved the Day For Eastern Seaboard

THIS is a story of how the Atlantic Seaboard of the United States, faced with an acute oil famine, has been saved from such a calamity. It is a story of a "revolution" in transportation — a story of how, almost overnight, the method of supplying the densely populated East with oil was radically changed to meet a critical situation.

It is a story, too, of close cooperation — cooperation between the railroad industry and the petroleum industry; between the railroads and the tank-car owning companies; between the railroads and the government, and between and among the railroads themselves.

The story really begins many years ago. At that time, the railroads were handling a considerable proportion of the oil movement throughout the country. This situation remained pretty much the same until after the first World War, when the railroads lost a great deal of the oil traffic to the ocean-going tanker, the barge, the pipeline and the truck.

By the time the present conflict began, the railroads were virtually out of the business of supplying the East with oil. For years, not more than 5,000 barrels, or about 200,000 gallons, of oil a day were delivered to the Eastern Seaboard by railroad tank car. As recently as the spring of 1941, the daily rail movement of oil into this district averaged only 11,250 barrels, or about 450,000 gallons. This was less than one per cent of the petroleum requirements of the East Coast at that time. The great bulk of these needs was met by tanker and barge shipments.

But Hitler's invasion of Poland in September, 1939, was to change all that. The first indication came about the middle of 1941 with the allotment of fifty United States tankers to replace British-owned vessels that had been sunk by the enemy. It was then estimated that the shortage of petroleum in the East, as a result of this diversion of tankers to off-shore service, would be approximately 175,000 barrels a day — not a great amount, but certainly tremendously more than the railroads had been bringing into eastern territory.

The railroads were asked what they thought they could do to help meet the emergency. They were prepared for this question, because several months before they had been advised of the possibility of withdrawing some of the tanker fleet and had made a survey of the tank car field. On the basis of this information, John J. Pelley, president of the Association of American Railroads, told the United States Senate committee investigating the gasoline and fuel-oil situation that the railroads, if called upon to do so, could bring 200,000 barrels of oil a day from the producing areas to the Atlantic Seaboard. His estimate was regarded by some at that time as impossibly high, but subsequent events have proved that he was exceedingly conservative.

The North Atlantic situation eased. Some of the tankers which had been lent to Britain were returned to American service; the railroads did not

have to haul oil in anything like the quantity estimated; the shortage passed over, and the East resumed its wonted way with oil.

But this was not to last for long. The Japanese attacked Pearl Harbor on December 7, 1941, and this was followed by the declaration of war between the United States and the Axis powers. German submarine packs began to roam North Atlantic and Gulf waters, and their attacks on ocean shipping increased steadily. Tank ships were diverted from coastwise commercial routes to offshore service in both oceans.

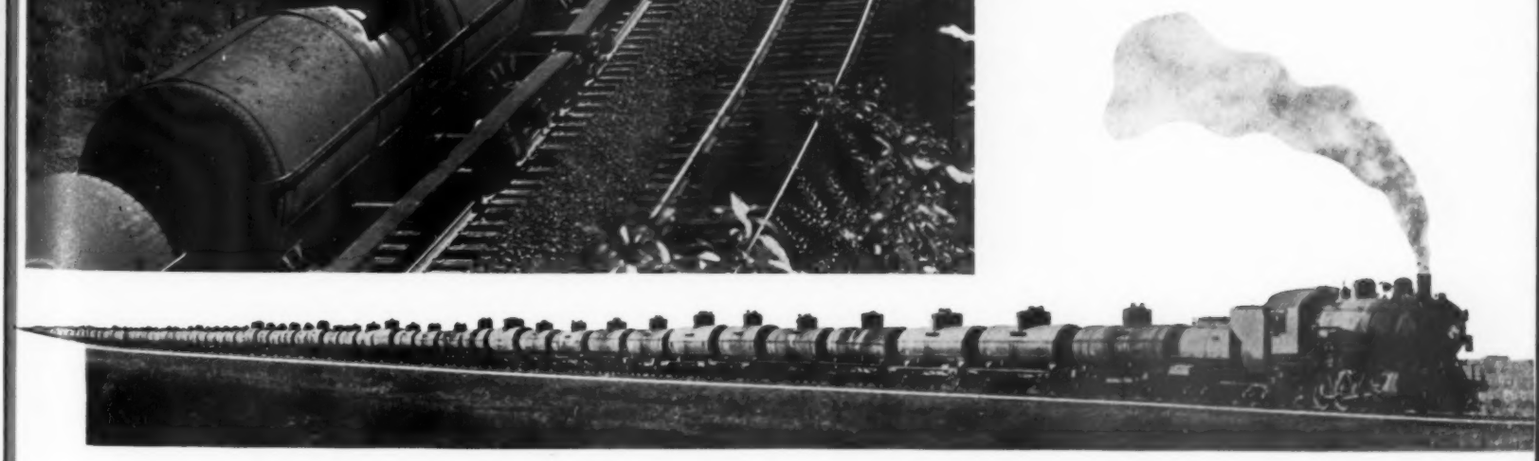
Suddenly, the East discovered that the way to which it had been accustomed to receiving oil for years was completely disrupted. It realized that unless new ways could be found, and found at once, the Atlantic Seaboard would suffer severely from an oil shortage. Consequently, the railroads were called upon to pick up the load. Fortunately, the crisis found the roads ready to do all they had promised. Indeed, as events proved, they accomplished three and four times what they had promised. Fortunately, too, there were already in effect emergency reductions in rates on petroleum and petroleum products into eastern territory.

In September, 1941, at the instance of what was then the Office of the Petroleum Coordinator for National Defense, the railroads and the oil companies had worked out a new basis of rates for both crude and refined products moving between the fields in the Southwest and the pipeline terminals in Illinois, on the one hand, and all destinations along the Atlantic Seaboard on the other. These new reduced rates, arrived at in

John J. Pelley, President, Association of American Railroads.

Oil moving to the East in solid trains of tank cars.

an all-day conference between traffic representatives of the two industries, were approved by the Interstate Commerce Commission in record time for so widespread and important a readjustment of freight charges. They went into effect on September 15, 1941, and ranged from 25 to 50 per cent, depending upon the commodity to be transported and the origins and destinations involved. On the basis of the present movement, the reduction amounts to more than $150,000,000 a year.



William E. Callahan, Manager, Tank Car Section, Association of American Railroads.

Therefore, when the great and unprecedented demand came for movement of oil by rail to the East, there was no problem of rates. The problem was one of equipment to haul the oil and facilities to load and unload it. It was a job for the oil companies, the tank car line companies and the railroads, all working together. The oil companies' part of the job was to provide the facilities for loading and unloading tremendously increased fleets of tank cars; the tank car companies' part was to locate and bring into service thousands of cars, many of which had been idle for a long time; the railroads' part was to furnish motive power, track and other necessities for collecting, moving and delivering the cars.

So well were the different parts of the job done that by the end of February of the war year of 1942, the volume of oil coming into the East by rail was up to more than 300,000 a day, as compared with the 11,250 barrels of less than a year before. The goal urged by Petroleum Administrator for War Harold L. Ickes at that time was half a million barrels a day, this being considered on all sides as the approximate limit of the extent to which the movement of tank cars on tracks could replace the movement of tank ships on the ocean.

To assist in reaching this goal, the Association of American Railroads, in April, 1942, created in its Car Service Division, a special tank car section, to deal with the movement and railroad handling of such cars. William E. Callahan, a practical and efficient railroad operating man, was appointed manager, and headquarters were established in Washington. The staff has been enlarged from time to time until now it consists of about sixty people, a number of them field representatives.

Beginning on August 1, 1942, a plan was set up to expedite the delivery of East Coast oil shipments. This plan provided for the bulk movement of oil in trainloads or blocks of cars going from one origin to one destination under so-called symbols, which served to identify the various schedules. In a short time, about sixty of these trains, with an average of close to sixty tank cars each, were leaving the oil-producing fields each day bound for the Atlantic Seaboard, and a like number of trainloads of empty cars were starting from the East for more loads. The trip in both directions was made on schedules that substantially reduced the normal running time.

As a result of this plan, together with the helpful cooperation of all concerned, the rail movement of oil to the Eastern Seaboard continued to increase until the average number of barrels handled per day reached 856,710 during the week ending September 19, 1942. From this level, there was a drop during October, November and December amounting at times to as much as 100,000 barrels a day. The decline was due to such things as changes in the nature of the demands made upon the limited tank car supply; increased military movements, heavy holiday traffic and unfavorable weather conditions. Since the first of the year however, the trend has been upward again, and the railroads are now bringing into the East well over 800,000 barrels, or more than 34,000,000 gallons, of oil a day. The improvement was due partly to the revision on December 28 of the symbol routes established the previous August.

The transportation of so vast a quantity of oil by rail requires the constant service of more than 70,000 tank cars and something like 1,500 locomotives. It is accomplished only by dividing the heavy load among numerous railroad routes to avoid overloading on one line while leaving others relatively unused. It is accomplished, too, only by unremitting attention from the oil companies, the tank car companies, the railroads concerned in the movement, the Tank Car Section of the Association of American Railroads, the Office of Defense Transportation and the Office of the Petroleum Administration for War. All of these agencies, cooperating with one another, have brought about what Administrator Ickes termed a "revolution in transportation," and have done what the Senate Special Committee to Investigate Gasoline and Fuel-Oil Shortages very recently described as a "magnificent job."

Great as the job has been — and it has been the more remarkable because it has been carried out under emergency conditions and with no thought of its being a permanent change in the method of supplying the East with oil — it did not suffice to provide enough gasoline for all driving on the East Coast this winter, nor enough fuel oil to keep every house warmed to its accustomed temperature. But if it had not been for the way in which the railroads rose to the emergency, the situation would have been not merely inconvenient and uncomfortable, but calamitous.

Neither the railroads nor any of the other agencies concerned are completely satisfied with what has been done. They realize that an even better job can and must be done, and they have set out to do it. They are determined to increase the flow of oil by rail to the East to more than 900,000 barrels a day.

Plans to accomplish this were revealed by Mr. Pelley to the special Senate oil investigating committee on January 27. These plans, Mr. Pelley said, include the assignment of additional tank cars to long-haul eastern service as a result of turning over more oil to motor trucks for short hauls; the shortening of unloading time by additional facilities; the shortening of the rail haul on the oil which is flowing from Texas to Southern Illinois through the "big inch" pipeline, and the use of metal drums to carry oil in box cars.

Another step was taken on March 1 when a new symbol plan of the Office of Defense Transportation became effective covering the movement of approximately 87 percent of all the oil into the East, and of the empty tank cars going back. Under this plan, there are forty major points of origin in the field territories and in the Midwest where existing pipelines terminate. In addition to these forty points of origin, there are more than one hundred other points at which less-than-full-train shipments are loaded and moved to concentration points at Denison and Texarkana, Texas; Kansas City, Missouri; New Orleans and Shreveport, Louisiana; North Little Rock and Pine Bluff, Arkansas, and Tulsa, Oklahoma. At these points, the cars are made up into full trains for the long haul East.

From the forty major points of origin and the eight concentration points, between seventy and eighty symbol trains are operated each day, with from thirty to 170 cars traveling under each symbol. The whole movement aggregates nearly 4,000 tank cars of oil per day.

A good example of how a typical oil train is handled under the symbol plan can be seen from the operation of "101-G" — the train that leaves Pine Bluff, Arkansas, at 4 A.M. each day for Buffalo, New York, and points beyond. This train is for the small producer who does not ship in trainlots, and is made up of cars originating at fourteen points in Louisiana and Texas. The Louisiana originating points are Cotton Valley, Ecco, Haynesville, Hinkle Station, Princeton, Rodessa, Rufus, Shreveport, Superior and West Lake, and those in Texas are Graham, Mount Pleasant, Sewell and Talco.

When the cars starting from these points arrive in Pine Bluff they are assembled into a solid train for the 67-hour trip to Buffalo, 1,133 miles away. Although this train, which usually operates in several sections, passes over the lines of three railroad systems, the movement is carried out as though it were over only one road.

On the departure of the train over the St. Louis Southwestern Railway, a wire is dispatched to the Tank Car Section of the Association of American

Railroads in Washington to the effect that the train is on its way eastward. This information, together with that contained in the 400 to 500 similar telegrams received by this agency each day, is recorded on charts, not unlike those to be found in the office of the Military Transportation Section of the A.A.R., which deals with the rail movement of troops and war freight. Other wires are sent to Washington each time the train is delivered to a connecting line, and again when it reaches final destination. In this way a check is constantly maintained on the progress of all oil trains in the eastern movement.

The first leg of the journey of the "101-G" is to Thebes, Illinois, a distance of 274 miles, which is to be covered in nineteen hours. At Thebes, the train is turned over to the Chicago & Eastern Illinois Railroad for handling to Thornton Junction, Illinois, a distance of 360 miles to be run in twenty-two hours. The final jump is the 499-mile stretch from Thornton Junction to Buffalo over the lines of the Grand Trunk-Canadian National Railways systems, to be completed in twenty-six hours. At Buffalo, the solid train breaks up, and the cars spread out to destinations in New York State, New England and points in Pennsylvania and New Jersey. The empty cars make the return trip from Buffalo to Pine Bluff in the same manner and over the same route. As in the case of the loaded movement eastward, telegraphed reports are constantly being received by the Tank Car Section concerning these train-lots of empties designated as "101-R."

One of the reasons why the all-tanker trains can operate on fast schedules — schedules that have reduced the normal running time as much as three days—is that, in many instances, all switching en route has been eliminated. Of course, switching is necessary when a car must be cut out because of disability, but even this part of the job has been speeded up so that the train will be off again in record time. Sometimes a car is repaired while the locomotive is being serviced or the train is being inspected, and is then allowed to continue the trip.

Until recently, a crippled car belonging to a tank car company could not be repaired by a railroad if the cost of the work exceeded fifty dollars. Instead, it had to be sent to the shops of its owner. This naturally delayed the car's return to service, so the tank car people have agreed to let the railroads repair the cars provided the job doesn't go beyond $250.

Due to constant study and investigation, so-called bad-order tank cars are being kept to a minimum. A Tank Car Maintenance Committee, consisting of representatives of the Office of Defense Transportation and of the Mechanical Division and the Tank Car Section of the Association of Railroads, is now working to the end that no tank car will remain idle because of disability.

An advantage of keeping tab on oil trains is that

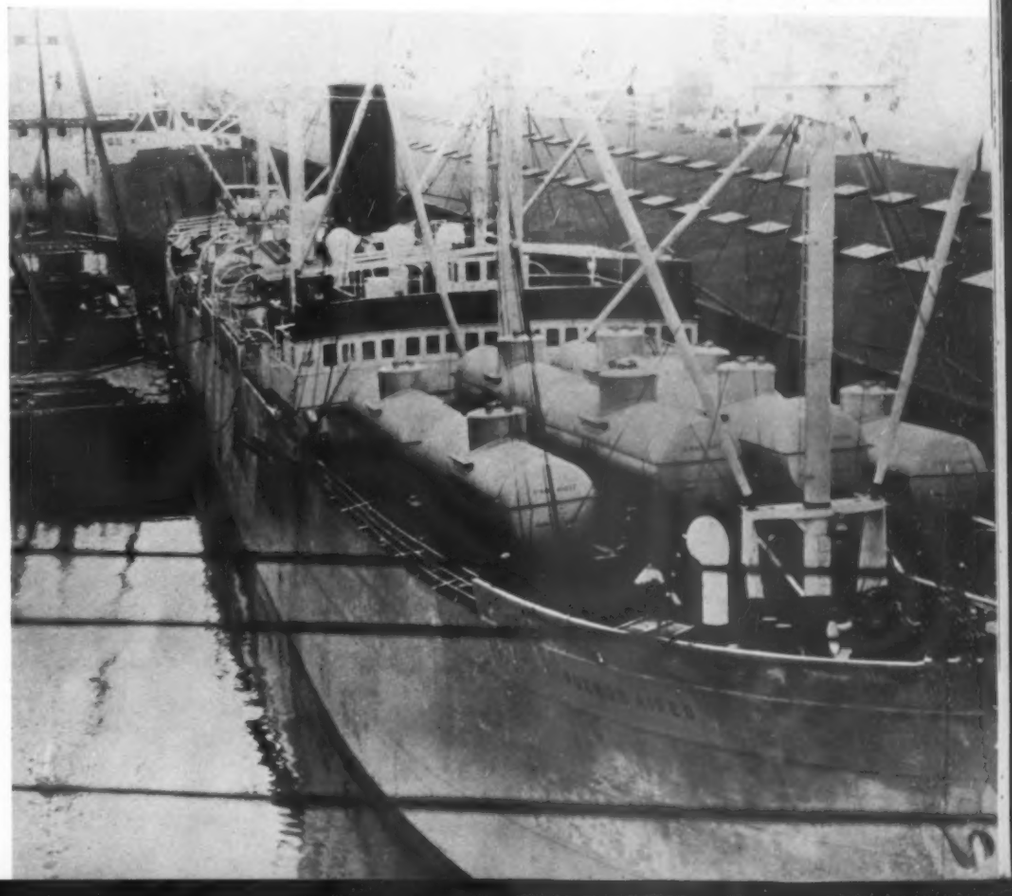
Tank cars shown at loading rack. Each car holds an average of 200 barrels and is unloaded in 3½ hours.

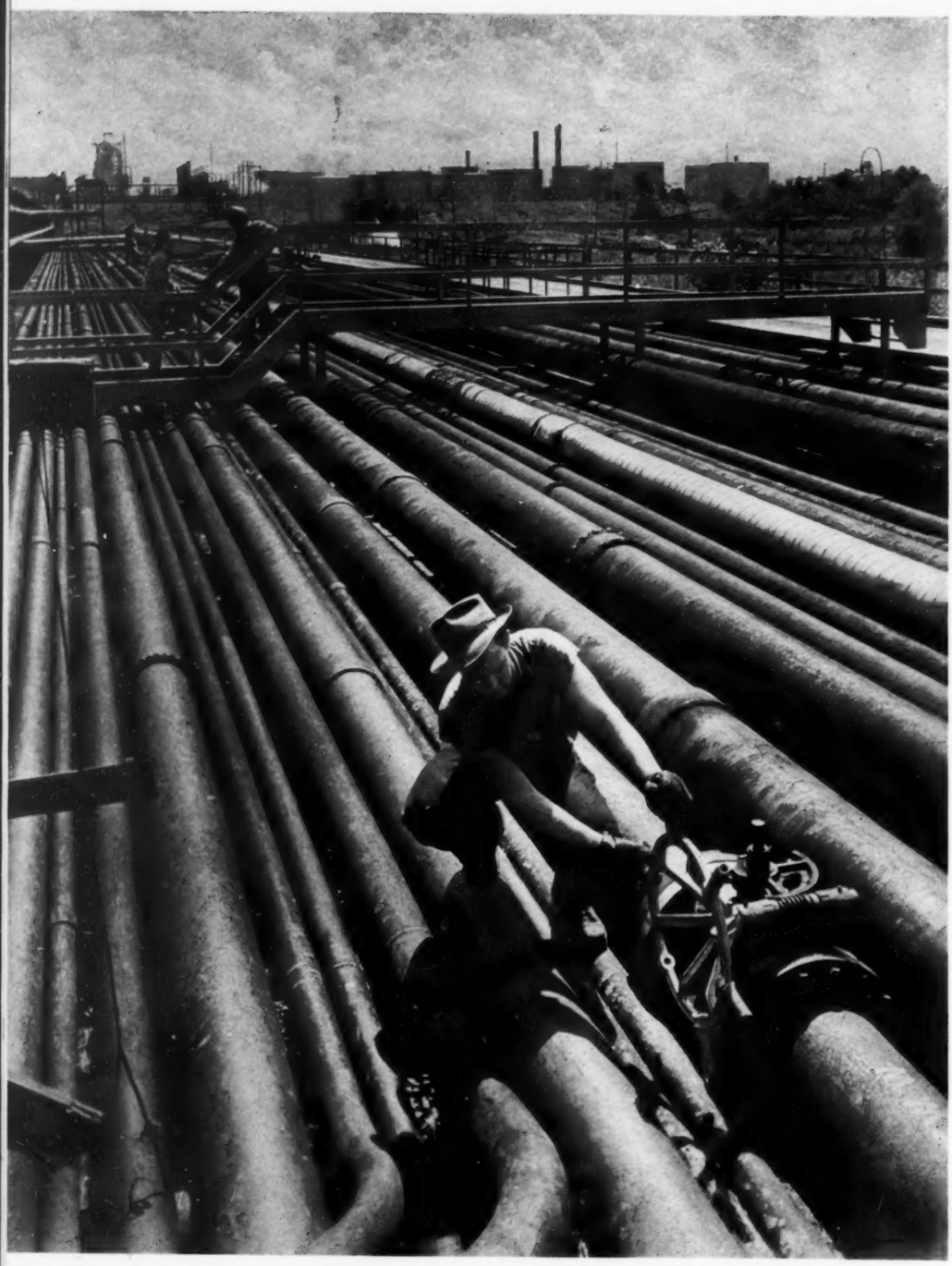
individual loaded cars or whole trainloads of them may have to be diverted while in transit. This action may be necessary because of extreme weather conditions, power shortages or other emergencies, or because unloading capacity is more readily available at one point than at another.

Ever since the emergency developed, the oil companies have done a splendid job of prompt loading and unloading of cars. They have cut down the time ordinarily required for this purpose by increasing loading and unloading facilities, and, in many instances, by working their crews twenty-four hours a day. The railroads have helped by providing special switching service to meet demands and by frequently grouping cars according to commodities, indicating on the waybills what the cars contain.

It is this sort of teamwork on the part of the railroad industry and the oil industry and the government agencies that is responsible for meeting and mastering a serious crisis of the war. It is the sort of teamwork that will bring about the stepping up of the oil movement by rail to the Atlantic Seaboard and the improvement of a situation which has grown more critical with the events of war. That accomplishment in itself will be a major contribution to victory.

Tank cars on board ship ready for shipment to Trinidad Army Supply Base.





Crude oils, after shipment from various parts of the United States, are segregated in these many miles of pipe for delivery to the refinery where 100-octane aviation gasoline is manufactured. The operator is opening a valve to let a batch of this crude flow to its destination. Photo courtesy Standard Oil Co. (New Jersey).

TRANSPORTATION CHANGES

to Meet War Conditions

FIRST SUGGESTION that conditions arising from the war might make it necessary or advisable to alter existing methods of moving oil from the great producing districts of the Gulf Coast and Midcontinent to the important consuming areas east of the Alleghanies was advanced in 1940. At that time Secretary of the Interior Ickes proposed the construction of a large capacity pipe line between East Texas and the Atlantic Coast. As Mr. Ickes himself has related* the suggestion attracted little attention and most of the comment regarding it was unfavorable.

At that time nearly 95 percent of the oil requirements of the eastern area were supplied by ocean tankers, 1,400,000 bbl. or more per day. A small amount, about 40,000 bbl., was coming through by pipe line and a still smaller quantity was brought in by barge. Tank car shipments were confined mainly to special products. America was not an active participant in the war though she was engaged in forwarding supplies to Britain and France. The prospect of any change in the prevailing system of transportation seemed too remote to deserve serious consideration.

This remoteness was lessened in 1941 when 20 percent of the tankers serving the Atlantic Seaboard were transferred to the movement of oil to Great Britain. The serious implications in this loss of transport facilities and in the possibility of further withdrawals immediately impressed the oil companies serving eastern territory and they began canvassing the potentialities of providing other means of moving oil. A committee of the American Petroleum Institute weighed the effect of the tanker diversion on the eastern supply situation and estimated that it would result in an average deficit of 494,000 tons (shipping) for the period from July 1, 1941, to March 31, 1942. On May 28, 1941, the President appointed Secretary Ickes to the post of Petroleum Coordinator for War and the Coordinator promptly renewed his recommendation of additional cross-country pipe line facilities.

At the suggestion of the Petroleum Coordinator a committee of the oil industry composed of executives from eleven companies handling 85 percent of the oil business in eastern territory took up the question of building one or more long distance pipe lines. The group selected as its chairman, President W. Alton Jones of Cities Service Company and appointed an engineering committee with W. R. Finney of Standard Oil Co. (N. J.) as chairman to make a complete preliminary study of the project. Engineering staffs of the oil companies concerned participated in this work which was completed about September 1, 1941. Their report was accepted by the committee of executives who moved immediately to set up two corporations, National De-

* See article by Secretary Ickes in WORLD PETROLEUM, December, 1942.

fense Pipelines, Inc., and Emergency Pipelines, Inc. These corporations, financed by the oil companies themselves, were to construct two pipe lines, a 20-inch line from East Texas to Southern Illinois, with a 16-inch connecting line from Wood River, Ill., and a 24-inch main line from Illinois to the Atlantic Coast refining districts around New York and Philadelphia.

This was an oil industry enterprise which the oil companies themselves were prepared to finance. It received the prompt approval of the Petroleum Coordinator but was stopped by the decision of the Supply, Priorities and Allocations Board, predecessor of the War Production Board, that the steel and other critical materials required for the construction of the lines could be more advantageously employed in other phases of the National Defense program. Shortly following the adverse decision of SPAB part of the tankers that had been assigned to the movement of oil destined for British use were returned. The supply situation in the eastern states eased temporarily, two privately constructed pipe lines came into operation and measures for expanding shipments by tank car were adopted. The project for a new cross-country pipe line system slipped into the background for the time being. It was not forgotten by Coordinator Ickes, however, by Deputy Coordinator Ralph K. Davies nor by the men who had planned the lines in behalf of the eleven oil companies. Their surveys, engineering plans and specifications remained on file for future use if and when needed.

Pearl Harbor changed the picture completely. It plunged the United States full force into the war. It meant the expansion of naval operations to all the oceans, the raising and transporting and supplying of armies overseas. It meant that ocean tankers could not for long be kept to the task of moving oil from one port to another in the United States. They had other, more compelling duties to perform.

Quickly the oil industry responded to the demands of the situation under the leadership of its own representatives and of the Petroleum Coordinator and his staff. At the call of the Coordinator the Petroleum Industry War Council was organized, made up of representatives from all branches of the industry and all parts of the country. Committees were set up to deal with all phases of oil industry operations from production to marketing. The vital problems of replacing tanker shipments by other means of transportation were assigned to a standing committee consisting of W. Alton Jones, president of Cities Service Company, Charles S. Jones, president of Richfield Oil Company, Burton W. Musser, director of Utah Oil Refining Company, E. G. Seubert, president of Standard Oil Company (Indiana) and H. C. Wiess, president of Humble Oil and Refining Company. W. Alton Jones, who had headed the earlier industry committees that planned the building of company owned lines from Texas to the East Coast, was appointed chairman of the committee the make-up of which included all geographical divisions of the country. Numerous sub-committees were established to deal specifically with tanker, tank car, pipe line, barge and motor truck transportation. The members of these sub-committees, acting in close cooperation with the Transportation Division of the Office of the Petroleum Coordinator, the Office of Defense Transportation, and other government agencies, set to work on the many angles of the tremendous task of finding new means of moving more than a million barrels of oil daily into the eastern section of the country — District No. 1 in the parlance of the industry.

It was realized that in the revision of the transportation system to replace the almost total loss of customary methods of supply that would result from the removal of all or nearly all the ocean tankers used in Gulf-Atlantic service it would be necessary to bring into play and to employ to the fullest possible extent every other facility that could be made available. It required rounding up and placing on long distance runs every tank car that could be found. It called for the building of more tow boats and river barges. It demanded that a veritable river of oil be started rolling eastward through pipe lines, old or new. It involved the use of motor trucks to replace railway equipment previously used in the local distribution of products. When the best that could be expected from each of these was added up the total was still tantalizingly short of the full military and civilian requirements of the eastern industrial area; a shortage of 400,000 to 500,000 bbl. daily remained.

Some possibilities were under-estimated. The best that railroad representatives could promise in the summer of 1941 was that they could move 200,000 barrels a day with certain operational changes. Even this was regarded in many quarters as a wildly optimistic forecast. Less than twelve months later, however, cars carrying four times that quantity of oil were rolling into eastern territory each day. Scarcity of materials and machinery stood as the greatest barrier to new construction. Motors, engines, pumps, valves, everything made from steel, was under priorities for use in building war plants and war equipment. The impossible task of moving more than a million barrels of oil a day had to be accomplished somehow or other with reliance largely upon makeshift methods and materials.

Reconstituting the pipe line set-up to provide a vastly increased eastward flow of oil and oil products presented many difficulties. Most of the country's pipe line mileage was operated by oil companies as an adjunct to their manufacturing and marketing activities, either to supply crude to refineries or to move products to centers of distribution. Of the lines reaching the Atlantic Seaboard a majority were used to convey gasoline and other products westward to markets in the eastern central states. In the attempt to work out a number of routes for moving oil eastward from Texas and the Midcontinent a pipe line conference was called by Mr. W. Alton Jones to meet in Tulsa in March, 1942.

For three days and nights the nation's top-ranking pipeline executives and engineers combed the facts of the looming oil shortage along the eastern seaboard which was now becoming a stern reality. To war had gone the bulk of the tanker fleet that had fed the East with its unrestricted, million-and-a-half barrel a day river of petroleum and petroleum products. And "draft numbers" were up for all the rest. Caught between the loss of tanker bottoms and the multiplying demands for oil in war industry and war action, the eastern areas of the nation faced an oil famine the proportions and results of which no one could foretell unless—

Unless the seventy pipeliners convened in Tulsa and representing every foot and phase of petroleum pipeline operation east of the Rocky Mountains, with their colleagues in rail and inland waterway transportation of oil, could build, in record time, a new system of overland transportation for oil to the East. Oil for war had to move thus — or else. And the pipelines would have to carry a heavy share of the load.

The report of that now-famous Tulsa Pipeline Conference anticipated what the past twelve months have so decisively shown: that "the pipeline companies can be depended upon to render the greatest possible assistance in this essential war effort at the sacrifice of profit and convenience in the conduct of their businesses." Founded on a clear-cut projection of specific possibilities for increasing oil runs to the eastern seaboard, the conference report recommended ten projects:

1. To step up operations of all existing pipelines to full capacity.
2. To eliminate pipeline bottlenecks by construction of additional facilities with second-hand or small amounts of new material.
3. To encourage the exchange of crude oil and products, the adjustments of marketing zones to free tank cars, barges and Lake tankers, and to make supplies available to points where transportation facilities already existed or could be supplied most readily.
4. To construct new pipeline facilities with available second-hand materials to deliver petroleum to markets or at such points as would increase the efficiency of existing carriers.
5. To construct additional pipeline facilities with new materials for the delivery of the balance in supply needed to meet essential demand.

The Projects:

1. Increase the Texas crude movement north and east by enlarging certain sections of existing lines and by reversing the Tuscarora Pipe Line, to deliver an additional 25,000 b/d to the East Coast.
2. (a) Increase capacity of Plantation Pipe Line from 60,000 to 90,000 b/d by building intermediate stations with second-hand equipment, together with a supply line (b) and extension (c).

(b) Construct from material available a 10" line of 60,000 b/d capacity from Beaumont, Texas, to Baton Rouge and arrange to supply 30,000 of the throughput from the Baytown-Houston area through converting an old line, or trading products.

(c) Extend the Plantation Pipe Line from Greensboro to some point on an inland waterway northwest of Norfolk with second-hand pipe. This would move 30,000 b/d refined products farther north for barges and tank cars.

3. Construct a products line with material available from Fostoria, Ohio, across the state to Akron, to be supplied from the Shell, Standard of Indiana and Sohio gasoline lines, to deliver 15,000 b/d of refined products into the Sun-Susquehanna Line for movement into Western Pennsylvania.

4. Arrange to increase the tanker movement of products from the refineries on the Great Lakes to Buffalo where 10,000 b/d could be moved in Erie Canal barges or pumped through the Socony-Vacuum, Keystone and Sun gasoline lines into Western New York and Northern Pennsylvania.

5. Recondition and rearrange the Atlas Line from East Texas to Shreveport and El Dorado and lay some second-hand pipe to connect with the Standard's old line leading to Grand Lake on the Mississippi, for a movement of some 25,000 b/d crude or products up the river by barge, or for shorter tank car haul.

6. Construct a new 20" crude oil line from East Texas to Salem, Illinois, for 200,000 b/d. This line would be 550 miles long and would require 114,000 tons of new pipe and entirely new pumping units. This line could be used to shorten the tank car and barge movement on 100,000 b/d to the East Coast and the other 100,000 b/d would offset the indicated decline in Illinois basin production.

7. Convert an existing crude line to deliver 60,000 b/d of refined products from Houston to East Texas, and construct a combination 12" and 14" line for 75,000 b/d out of reclaimed pipe and equipment, from East Texas to a point above the junction of the Mississippi and Ohio Rivers near Paducah, Kentucky, for shorter barge and tank car hauls.

8. Construct an 8" line, if second-hand pipe and pumping units were available, from the Tinsley area to some point on the Mississippi — probably Memphis — to allow barge movement up the Mississippi and to shorten the tank car haul to the East Coast.

These eight projects contemplated an overall increase in pipeline runs to the East of 140,000 b/d of petroleum and petroleum products: 80,000 b/d would be direct inter-district pipeline deliveries: 60,000 b/d would result from more efficient tank-car trans-shipments over shorter hauls.

The completion of these projects would effect, in combination with estimated potential inland waterway and tank car movements, a daily average delivery of 900,000 b/d of oil to the Eastern seaboard — 400,000 b/d short of military, industrial and essential civilian requirements.

The logic of crisis needed no clarification. It was agreed that pipe lines represented the safest, most speedily and efficiently expansible medium for additional oil movements. Accordingly, the pipeliners made additional recommendations of Projects 9 and 10:

9. Construct a new 24" crude oil pipe line from East Texas to Salem, Illinois, with a capacity of 300,000 b/d and extend this line East to the refineries in New York and Philadelphia areas to deliver 250,000 b/d crude. This would be tied in with the Gulf Coast and West Texas reserves by existing pipe line facilities. 50,000 b/d would be dropped off at Salem. The 24" line would require 422,000 tons of new pipe and all new pumping equipment.

10. Convert the 20" line (covered in Project 6, preceding), to refined products, and extend it to some point in Western Pennsylvania to be tied into existing gasoline lines, or even farther East so that the full 200,000 b/d of products from the Gulf Coast refineries could be utilized in the North Atlantic States. The extension would require 187,000 tons of new pipe. The second-hand line under Project 7 could be converted to crude for 50,000 b/d.

This was the initial challenge the pipeline industry delivered to itself and accepted shortly thereafter when the Tulsa Conference proposals with minor revisions and amendments, were given official sanction and send-off under the terms of Recommendation 49 of the then Office of the Petroleum Coordinator for War.

The original Project 1 was amended to include the installation of additional pumping equipment and loops.

Projects 2, 3 and 4 were recommended without material change.

Project 5 was expanded to include the construction of a 158-mile, 10-inch products pipeline from El Dorado to Helena, Arkansas — a logical extension of the line reversed between Port Arthur and El Dorado — to an appropriate barge terminal on the Mississippi.

Projects 6 and 10 were recommended but subsequently shelved in the face of heavy critical steel requirements and in order to permit a longer-range development of the supply, demand and oil transportation facts on which the need for a Texas-East Coast 20" products line could be based.

Project 7 was expanded by a recommendation for the reversal and conversion of a 12" crude oil pipeline from East Texas to Houston for the northward movement of 60,000 b/d of refined products. Subsequently, three other lines roughly paralleling the route of this line, have been reversed and converted or are currently in process of reversal and conversion. Together, these four lines form the main feeder system from the Gulf for the War Emergency Pipeline.

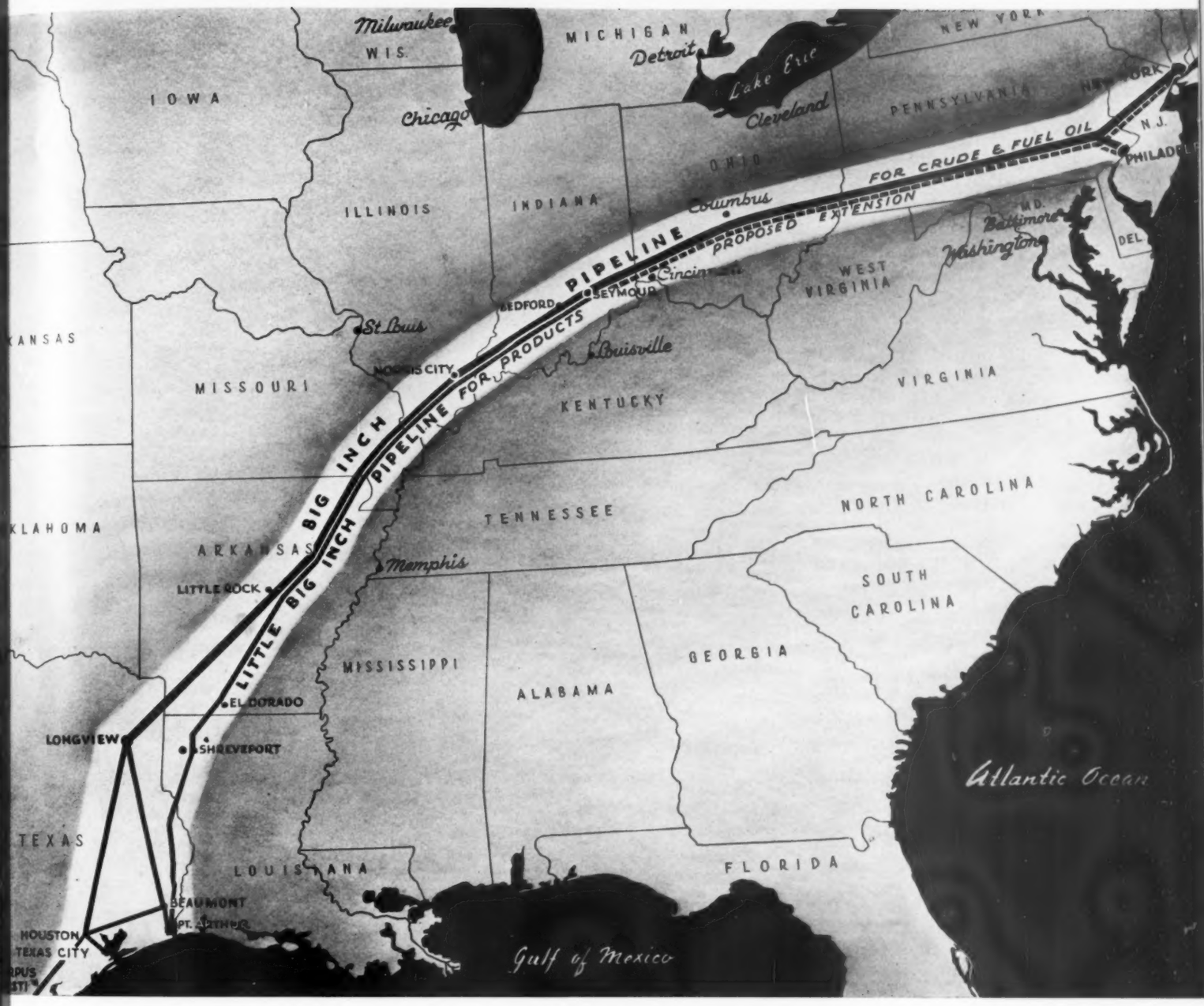
Project 8 was eliminated by OPC Recommendation No. 49 and Project 9 — the original "Big Inch" proposal — became Project 8.

Official approval of the proposals advanced by the Tulsa Conference followed quickly and the 1942 revolution in the petroleum pipeline transportation system was launched.

From West Texas to the Alleghanies of Pennsylvania pipeline crews hit the rights of way and the first of the 2,300 miles of pipe to be dug up and re-laid during the next twelve months came out of the ground, salvaged from facilities either idle or otherwise available for more essential war duty. Promptly, too, the pump station and terminal adjustments were initiated. Loops and links were laid as fast as second-hand pipe and other equipment and fittings could be made available. Pumps and motors were reconditioned and re-installed where their horsepower could add to the eastward-flowing tide of the pipelines. From the hinterlands to the halls of WPB pipeliners and PAW transportation men prayed and pleaded for the limited amounts of new material and equipment needed to round out the structure and the efficiency of the overall program.

Today, twelve short months after that groundwork meeting in Tulsa, approximately ninety-five percent of the program originally undertaken has been completed. Pipeline deliveries of oil to the East are running at about 200,000 b/d and the effect of pipeline construction and adjustments on East Coast deliveries by tank car and inland waterways is well above the 60,000 b/d originally estimated as probable.

The revolution in oil transportation is well along the highroad to complete accomplishment — far beyond the point where there can be any question of its assured success. It has been brought about by consistent team work between industry and government; by the willingness of oil companies to sacrifice their immediate interests to the nation's cause; by the careful planning of members of the transportation committees and their engineers; by the ceaseless fight of pipe line builders and their crews against mud and freshets, frost and snow, in thrusting the lines eastward through swamps and over mountains; by the marvellous record of the railroads in holding the line during a most critical period; by the consistent backing and support extended by the Petroleum Administration, Defense Transportation, Defense Plant Corporation, the War Production Board and other federal agencies. It all sums up to a realization of the motto that hangs on the wall of petroleum headquarters in Washington: "The difficult task we perform immediately; the impossible may take a little longer."



Main lines of War Emergency System with combined daily capacity of 535,000 barrels.

"BIG INCH" IN OPERATION

ON FEBRUARY 19TH, 1943, the first oil transported through the first section of the War Emergency 24" line from Longview, Texas, to Norris City, Illinois, was loaded aboard tank cars, switched out of the terminal and dispatched on its way to the East. The first section of this gigantic undertaking had reached a sufficient stage of completion to allow of partial operation just 200 days after construction work had begun.

Pipeline construction crews, under the direct leadership of Burt Hull, whom War Emergency President W. Alton Jones describes as the world's best pipeliner, had turned in a performance record in which they take justifiable pride. Finishing touches yet remain to be made at some of the pump stations and at one of the loading racks in order to provide for full capacity operation. This work is rapidly reaching a completion stage and by the end of March, 1943, the 531-mile line from Texas to Illinois should be ready to operate at about full capacity which is 300,000 barrels per day.

Meantime, construction work on the extension from Norris City to New York and Philadelphia is being pushed despite the adversities of climate and natural hazards of construction through the Allegheny Mountains. Here the pipeline construction crews have battled old man winter with his alternating snows and sleet, freezing and thawing but these hardy pioneers will not be stayed and they vow that such obstacles can only temporarily interfere with the determination to complete the line to the Atlantic Seaboard by the early summer of 1943.

Pending completion of the Eastern Extension, the interim plan of operation for the first section has been inaugurated. The facilities, owned by Defense Plant Corporation, have been leased to Defense Supplies Corporation, another R.F.C. subsidiary, and it is for the account of the latter that War Emergency Pipelines, Inc., will buy, transport and deliver crude and heating oils.

Thus War Emergency Pipelines, Inc., acts as agent for Defense Supplies Corporation. The "big inch" line will not be a common carrier as are privately owned oil pipeline systems in the petroleum industry, but instead will be, as the corporate name aptly implies — an emergency facility owned by and operated for government agencies in the prosecution of the war effort. The line will alternately transport crude oil and Number 2 heating oil. For example, the tentative schedule for April contemplates the movement of an average of 175,000 barrels of crude oil and 125,000 barrels of heating oil per day. Alternate batches of crude oil and heating oil will be shipped through the line in slugs of from 600,000 to 1,200,000 barrels. This will be so regulated that receipts at the terminal by the end of the month will have approximated the averages indicated above.

Volume operation of the line will be in accord with instructions and schedules issued by the Transportation Division of the Petroleum Administration for War under the authority of Petroleum Directive 63. This Directive provides that schedules issued thereunder shall be based upon the following general principles:

"Priority shall be accorded District Three sources of suitable crude oil and heating oil which may be made available with minimum disruption of essential refining operations and which may be transported most expeditiously by pipeline to the Longview terminus."

"Priority shall be accorded District One purchasers of crude oil at the easterly termini of the pipeline system who require the same for the manufacture of those war products deemed by the Administrator to be most essential. Such purchasers will be required to offer to sell an equivalent quantity to War Emergency Pipelines, Inc., as agent for Defense Supplies Corporation, at Longview, if the same reasonably may be made available by them, their subsidiaries, or affiliates consistently with the intent and purpose of this directive."

"Priority of designation for purchase of heating oil at the easterly termini of the pipeline system shall be accorded original suppliers in District One (as defined in Petroleum Directive 59, as amended (7 F.R. 10621 or as the same hereafter may be amended) whose railroad terminal facilities will best expedite movement of tank car trains operating between the easterly termini of the pipeline system and terminals in District One."

The schedules mentioned above designate the sellers of crude oil and heating oil together with the volumes which each is to deliver to the terminal facilities of War Emergency Pipelines at Longview, Texas. Also designated are the purchasers for whose account oil will be delivered into tank cars at Norris City, Illinois, or into the connecting Ohio Oil Company pipeline system for re-

Above: Releasing Big-Inch oil for second stage of eastward journey. Left to right: Burt Hull, W. Alton Jones, George H. Hill, Jr., and Deputy Administrator Ralph K. Davies.

Right: Citation presented to War Emergency Pipelines Co. by Administrator Ickes.

Below: Loading tank cars at Eastern Terminus of first section of Big Inch line.

delivery to tank cars at loading racks located at Benton, McLeansboro, Bridgeport and Martinsville, Illinois. At the present itme, Defense Supplies Corporation, for whom War Emergency is acting as agent, will purchase crude oil delivered at the reeciving facilities of War Emergency at Longview, Texas, at field posted price plus published pipeline delivery charges and will purchase heating oil delivered at the same receiving facilities from coastal refineries, at the refinery price of such heating oil plus pipeline delivery charges. Both crude oil and heating oil will be sold at the Norris City terminal at the foregoing purchase prices plus 40 cents per barrel.

In addition to the main line, the physical facilities of War Emergency, as presently completed or practically completed, consist of two gathering systems in East Texas extending from the Longview receiving tanks to convenient delivery points of suppliers in East Texas.

One of these systems is for crude oil and the second for heating oil. The heating oil gathering system connects with private carriers, on the trunk lines of which heating oil purchases originate at principal refining centers on the Texas Gulf Coast. At the Longview station adequate tankage, totaling approximately 1,200,000 barrels, will be available for handling crude and heating oil receipts from which accumulation points these commodities can be switched at will into the main line of the corporation for the journey northeast to Norris City. At the latter point tankage having a gross capacity of about 1,300,000 barrels will shortly be available for the receipt of shipments from East Texas. At the Norris City terminal three loading racks have been provided, each having a capacity of close to 100 cars per spotting and the railroads will be able to handle out of this terminal between 900 and 1,200 cars per day. From Norris City, a short 14″ branch line has been constructed by War Emergency Pipelines, Inc., to the Enfield station of the Ohio Oil Company. This branch line is now in operation and deliveries by War Emergency through this facility are approximating 40,000 barrels per day.

The over-all plan of the WEP system has been designed with an eye to future supplies to be obtained not only from the East Texas field and refineries on the Gulf but also from other southwestern fields and refining areas, starting out with an aggregate capacity of about 190,000 barrels per day which previously carried East Texas crude oil from the East Texas field to either the Houston or Port Arthur areas on the Gulf. These lines are the Pan-American 12″ and the Shell 10″ with terminals at Houston and the Sun-Stanolind 10″ and Atlantic Pipeline Company 10″ with terminals in the Port Arthur area. The Atlantic line will be used to transport crude oil northwest to Longview, Texas, while it is presently contemplated that the other three lines will be used as feeders delivering Number 2 heating oil from coastal refineries to the Longview terminal of War Emergency.

Above: Interior of pump room in Emergency line station.

Below: Typical pump station on War Emergency Pipe Line.

"LITTLE BIG INCH"

Adds Important Unit to Emergency Pipe Line System

"Little Big Inch" as it is often referred to among pipeliners to distinguish it from the original "Big Inch" is the latest and one of the most important components of the emergency pipe line plan. While the purpose of the 24-inch line, now in operation through the first half of its course, is to bring crude and fuel oil to the Atlantic Seaboard the 20-inch products line is designed to move gasoline from Gulf Coast refining centers into this same eastern area. The necessity of increasing deliveries of gasoline to the East Coast to meet growing military demands is the primary reason for the laying of an independent line devoted to this purpose.

At the January 6, 1943, meeting of the Temporary Joint Pipeline Managing Subcommittee the committee recognized the compelling need for this 20-inch products line and recommended that it be built as promptly as possible. This recommendation was adopted as a result of comprehensive engineering studies made by the engineering subcommittee and predicated on estimates of probable military requirements for petroleum products which could best be delivered at Atlantic Seaboard points. Concurrently, the Transportation Division of the Petroleum Administration for War was making independent studies of the need for the 20-inch products line.

On January 18, 1943, the Petroleum Administrator for War filed a request with the War Production Board for the allocation of the necessary critical materials to construct the first section of the products line from Houston and Beaumont, Texas, to Norris City, Illinois, and Seymour, Indiana, a distance of approximately 836 miles. The War Production Board acted promptly on the required materials on January 26, 1943. The Petroleum Administrator made it plain at the time of his request for these initial materials that a further study would be made not later than May 1, 1943, as to the necessity for completing the line through to the Atlantic Seaboard. On March 3, 1943, the Administrator announced that he had formally applied to the War Production Board for the materials necessary to complete the project to New York and Philadelphia. Detailing the need for completing the line, Administrator Ickes said,

"In the light of current developments, particularly in the military sphere, and the future prospects so far as any of us can anticipate the future, it is my judgment that the 20-inch petroleum pipeline from Texas, the first installment of which to Norris City, Illinois, and Seymour, Indiana, has already received the approval of the War Production Board, must be completed through to the Eastern Seaboard.

"We cannot await actual need—a need which as applied to petroleum may well be of the most critical character in the prosecution of the war on actual battlefronts."

As designed, the line will have a capacity of 235,000 barrels per day, operating at a pressure of about 750 lbs. per square inch. General construction details will follow practices established in the building of the 24-inch line. The 20" steel pipe will have a thickness of 5/16 inch. For the first section of the line from Beaumont and Houston, Texas, to Seymour, Indiana, there will be required a total of 160,000 tons of steel and about 2,200 tons of other critical materials. A total of 53,000 connected horsepower will drive the required 41 motors and pumps.

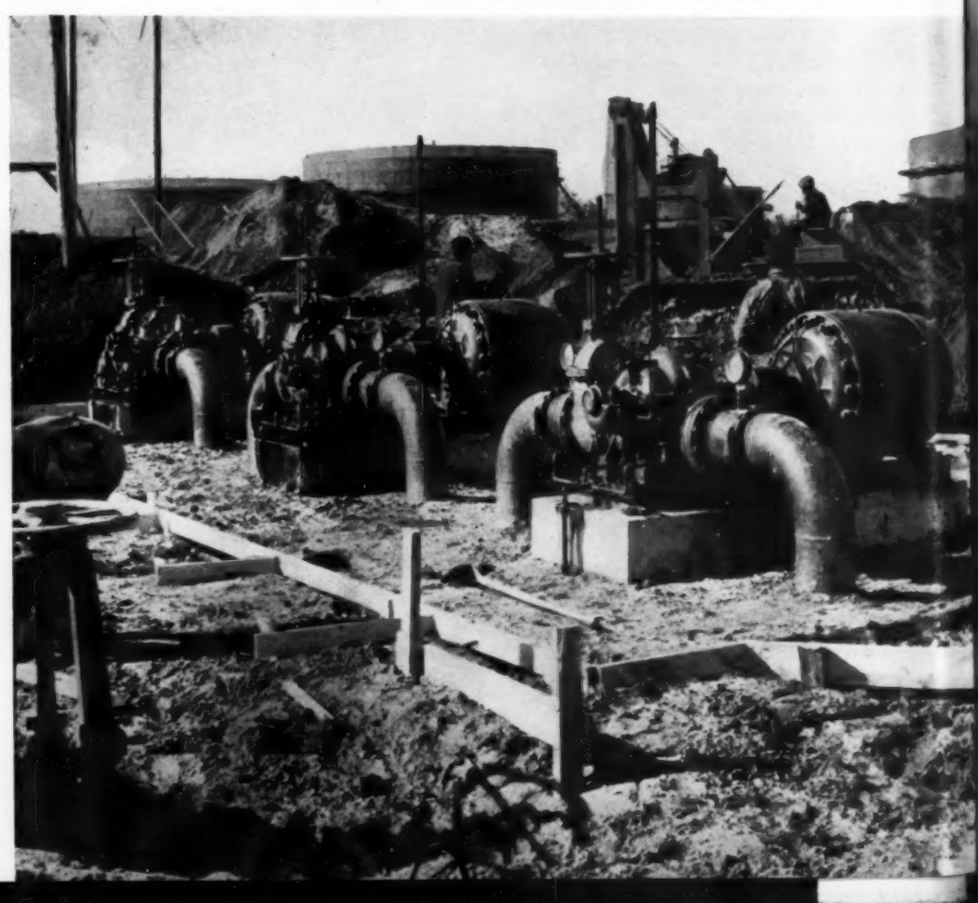
The western end of the line will be connected by feeders to refineries located in the Houston, Texas City and Port Arthur, Texas, areas. The main line will then follow a route northeast to Little Rock, Arkansas, from which point it will parallel the 24-inch line to Norris City and Seymour. Present construction plans contemplate completion of the first section of the products line by September 1, 1943. As this will be well after the completion date of the 24-inch line to the East, tankage and railroad loading facilities built at Norris City in connection with the 24-inch line will be available for reception and shipment of products to the East. Assuming approval of the Administrator's request to complete the line to the seaboard, tank car shipments from the midwest temporary terminal will only be required for about a four-month period. These tank car shipments will increase deliveries to the East by approximately 100,000 barrels per day while the completed line to the Coast will make the full capacity of 235,000 barrels per day available. This full capacity, based on engineering and construction plans, can be made available by January 1, 1944, if allocation of the required materials may be had.

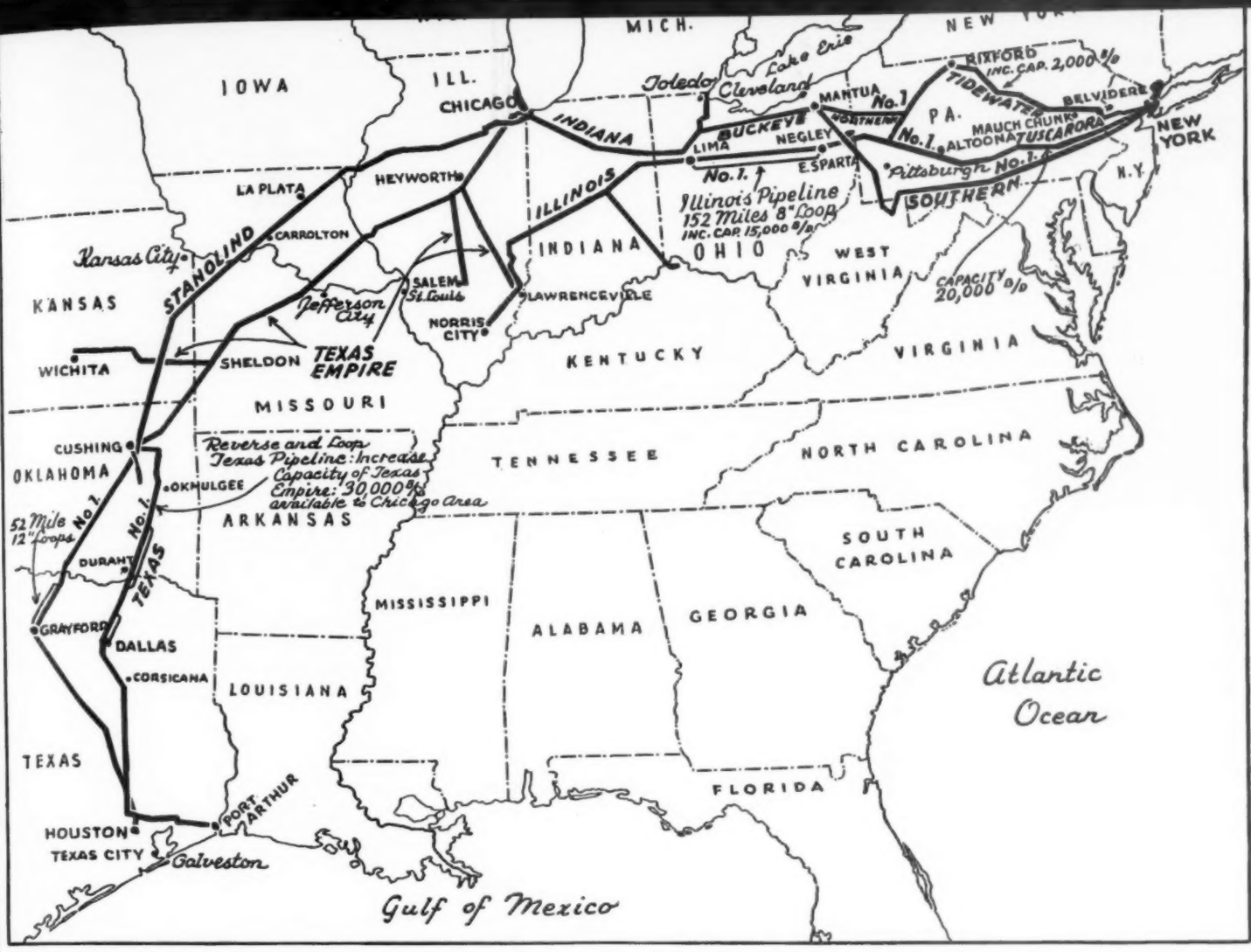
Construction of the 20-inch line will be supervised by War Emergency Pipelines, Inc. Contract between this company and Defense Plant Corporation has been executed. Ownership of the line will be in government agency, a subsidiary of Reconstruction Finance Corporation. As is true in the construction and operation of the 24-inch line War Emergency Pipelines, Inc., will continue to act for the government without profit to itself or its stockholders.

Surveys of the southwestern section of the route are well advanced and actual ditching operations are expected to start in the immediate future.

The estimated cost of the first section to Seymour, Indiana, is $44,000,000. Completed to the East Coast the total cost will approximate $75,000,000.

Below: Three Allis-Chalmers booster pumps located outside a main station on the War Emergency Line. They are rated at 3200 g.p.m. against a 110 ft. head, driven by 1750 r.p.m., 100 hp. motors.





PROJECT No. 1

Linking of Many Lines Adds 27,000 Bbl. to Eastward Flow of Oil

INTERESTING as an example of the complications involved in establishing through pipe line routes from Texas and Mid-continent fields to the East is Project 1 which has been worked out practically in accordance with the plan proposed by the Tulsa pipe line conference. Several different companies have cooperated in this undertaking. The longest stretch of new construction required was the laying of 152 miles of pipe across the state of Ohio but a considerable amount of looping, building of connecting links, reversals of flow and rearrangement of station facilities had to be provided. The result of these extensive hookups, as shown by the accompanying outline map, has been to create a through system delivering an increase of 27,000 barrels daily to the East.

Through reversal and looping of the Texas Pipe Line north from West Dallas and installation of loops on a section of the Stanolind line between Grayford, Texas, and Healdton, Oklahoma, the capacity of these lines has been materially increased. At Cushing, Oklahoma, the Texas Pipe Line connects with the Texas-Empire system and at Healdton the Stanolind makes delivery to the Oklahoma Pipeline Company system. The Texas-Empire Pipeline system from Oklahoma and West Kansas to the Chicago area was considerably expanded by the addition of intermediate stations, installation of pumping equipment in some of the older stations and by extensive looping especially at the northern end of the system. As a result of these changes the capacity into the Chicago area was increased by 30,000 B/D. On the eastward part of the project, the facilities of the Indiana and Illinois pipelines are utilized. The Illinois Pipeline Company increased the capacity of its system between Lima and East Sparta by 15,000 B/D. This was accomplished by laying 152 miles of 8" loop between those two points. The Buckeye Pipeline Company increased its carrying capacity as did also the Northern, National Transit, Southern and Tidewater systems. Flow in all of these facilities is toward the East and with the exception of Tidewater and Southern they act as feeders to the Tuscarora, the latter previously having been a products carrier from New Jersey to Western Pennsylvania but now transporting crude oil to the East.

The carrying out of this program involved a vast amount of detailed work on the part of the engineering and construction forces of the companies concerned. The entire project is an intercompany enterprise. The pipe and other materials used in building connections and loops had to be obtained by digging up and removing pipe from locations where it was not being fully employed or where it was not essential to the emergency movement. Old pump stations were revamped and new units were added. Equipment was borrowed, begged or "stolen" from branch lines and places where it was not in active use or not employed to full capacity. For example, the Illinois Pipe Line had a line in Indiana and Kentucky which it was decided could be dispensed with as other means of supplying that particular area could be provided. This yielded approximately 100 miles of 8-inch pipe for use elsewhere. Other pipe was found as far west as Texas. Pumps, valves and engines were collected by the different companies from all parts of their territory where they could be spared or substitutions found.

The increased movement made possible by changes in the different lines contributed various increases ranging from 2,000 barrels daily upward. The progressive completion of the various project features has resulted in periodic increases in eastern deliveries from time to time. All phases of the project with the exception of pump installations were completed by January 1, 1943. Installation of a second and final pumping unit on the eastern portion of the line which is now being finished will bring the delivery rate above the 25,000 B/D delivery originally contemplated.

PROJECT No. 2

Expanded Plantation Line Has 90,000 B/D Capacity

By F. W. Abrams,
Chairman, Project Management Committee

BY THE TIME this article appears gasoline and other refined products will be moving by pipeline nearly 1,200 miles from Baytown, Texas, to points as far north as Richmond, Va.

In some respects it is one of the most unique systems in the world. Some sections are of seamless steel pipe, others of odds and ends dug up from lines long abandoned. Some of the pumping stations are of modern construction, with the latest in electrical equipment, interlocking apparatus and automatic controls. In other locations you will find wooden buildings housing an odd assortment of new and second hand pumps picked up in widely scattered parts of the country. That products are being pushed in growing volume through such a system is a tribute to the persistence and resourcefulness of the pipeline engineers of several different companies who pooled their experience to tackle the job.

Nucleus of the system is the 800-mile Plantation Pipeline from Baton Rouge, La., to Greensboro, N. C., built with private capital and completed in January, 1942, at a cost of $21,500,000. The Plantation system has a capacity of 60,000 barrels a day, but the engineers who planned it were working with an eye to the future and made provision in the design of the equipment for its expansion should the need arise.

With the sharp reduction of tanker shipments to the East Coast at the very time when war industries were calling for increasing quantities of petroleum products, it became evident that the Plantation system would have to carry more gasoline. The need became more acute as offensive action overseas began to require large shipments from Atlantic ports. Although the capacity of the Plantation line could be increased, the additional quantities of products needed were not available at the southern terminus, Baton Rouge, which was being called upon to furnish large volumes through other channels. Out of this situation grew Project No. 2, which involved the following steps:

1. Construction of a line from Baytown and Beaumont, Texas, to connect with the Plantation system at Baton Rouge.
2. Expansion of the Plantation line from 60,000 to 90,000 barrels a day intake capacity.
3. Construction of a line from Plantation's northern terminus at Greensboro to the Richmond area on the James River.

The first and second parts of the project have been in operation since early in February, and the third is expected to be completed by the beginning of April. How this was accomplished makes an interesting story.

The Bayou Line — With a daily capacity of 60,000 barrels, the Bayou is able to supply the Plantation system with the additional 30,000 barrels a day required by the expansion program, plus half the Plantation's normal needs as well. Costing $7,000,000, the Bayou is the largest of the new war emergency pipeline projects to be privately financed. Six companies cooperated in supplying the necessary capital — Shell Pipe Line Corporation, Humble Pipe Line Company, The Texas Pipe Line Company, Pan American Pipe Line Company, Pure Transportation Company and Crown Central Pipe Line and Transportation Company.

The line was designed by engineers of the Shell Pipe Line Corporation, and the management pushed the job through to a successful conclusion. Shell also is responsible for operation of the system.

From Baytown the Bayou picks up products through feeder lines in the Houston area and carries them through 8" pipe over a 68-mile route to Port Neches. This section has a gasoline throughput of 37,000 barrels a day.

At Port Neches feeder lines pour in additional

Below: Another section of the 1,261-mile long Plantation Pipe Line is welded into place.

products from refineries in the Beaumont sector, and 10″ pipe carries the flow 183 miles to Baton Rouge. This trunk line can deliver as much as 60,000 barrels of gasoline a day.

The Bayou system was built almost entirely of reclaimed pipe. Crews went out into the field and dug up abandoned lines and others not needed for the war effort. Plows and ditching machines laid the pipe bare and torches cut it into convenient lengths. Whirring knives, torches and swabs cleaned the old pipe inside and out.

When the going was good a gang of 65 men moved along at a mile a day pace. When it wasn't, they wallowed through swamp and tangled undergrowth and pushed on just the same. All this old pipe was originally fitted with screw collars which had to be cut off with torches and the pipe bevelled for welding before it could be relaid.

There are 11 pumping stations in the system. To build them, the whole Texas area was searched for idle and abandoned pump units from which equipment could be dismantled and salvaged for the Bayou line. New equipment amounted to less than 20 percent of the cost of the entire project.

The Plantation Expansion — To get an idea of what was involved in the $4,000,000 expansion of the Plantation line, which was underwritten in part by throughput commitments on the part of the Texas, Pan-American, Pure and Crown Central Companies, it is helpful to refresh one's memory on a few highlights of the original project. For the job this time was quite different.

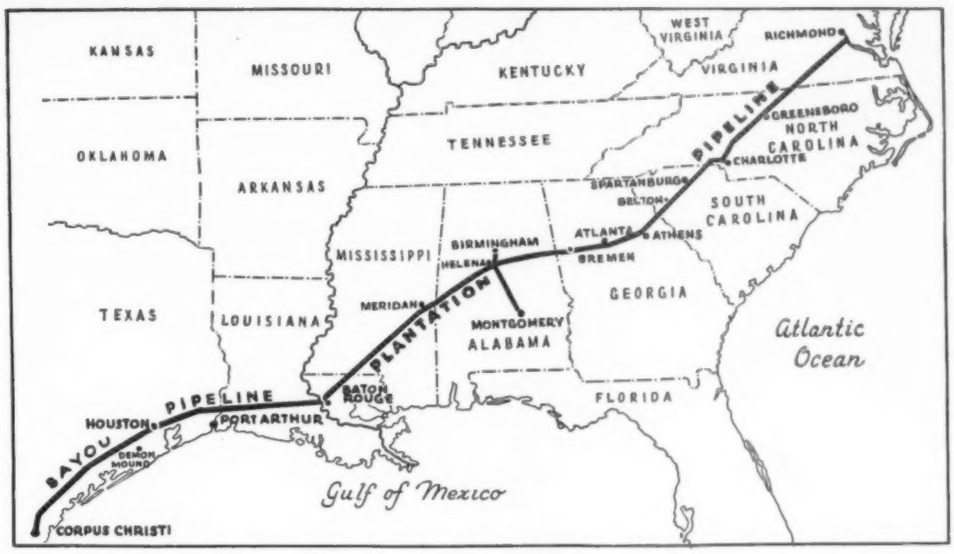
When the original project was finished early in 1942 the Plantation Pipeline was the most modern gasoline line of its size in the world. A joint undertaking of Shell Union Oil Corporation, Standard Oil Company (Ky.) and Standard Oil Company (N. J.), it was the largest ever built for the transportation of refined products. It was one of the world's longest all-welded lines.

The Plantation consists of a 12″ line from Baton Rouge, La., to Bremen, Ga., and a 10″ line from Bremen to Greensboro, N. C., with four branch lines of 8″ and 4″ diameter.

The original pumping stations were, and are, an engineer's dream. Fourteen of them were set at average intervals of 60 miles, with two additional stations required for dock pumping at Baton Rouge and for booster purposes at Chattanooga.

The entire Plantation system is electrically powered. The pumps are driven by 3,600 r.p.m. explosion-resisting induction motors, some of them the largest of their type ever built. When first completed, these powerful units could force 60,000 barrels a day of gasoline through the 12″ section and 42,000 barrels through the 10″ line.

Before the expansion various refined products, including several grades of gasoline, kerosene,



Diesel fuel and tractor fuel, were carried through the Plantation system at an average speed of four miles per hour. Plantation engineers worked out a way to reduce contamination of products to a minimum.

In other pipeline operations a "slug" of water was sometimes put in the pipe between batches of two different products. In the Plantation system shipments of different products move end to end, with little intermixing, by the simple expedient of maintaining the velocity of the oil in the line above a critical minimum figure.

At the various pumping stations the different shipments can be distinguished by their color or by the passage of a small quantity of dye between the batches. Another method of telling products apart is by a continuous graphic record of their specific gravity obtained by a highly sensitive gravitometer.

With this thoroughly modern system to start with, Plantation engineers tackled the job of a 50 percent boost in the line's throughput. This time there was no wide assortment of equipment from which to choose. They had to take what they could get and make it do.

Fortunately the probable need of such expansion had been foreseen in the original design. All the original stations on the main line had been equipped with pumps in which larger impellers could be readily substituted. The electric motors had been designed for operation at either 600 or 900 h.p., with a loss in motor efficiency of less than 1 percent over the entire operating range. The only work necessary to obtain the higher horsepower output was to change the pump impellers and enlarge the ventilating facilities in the motors.

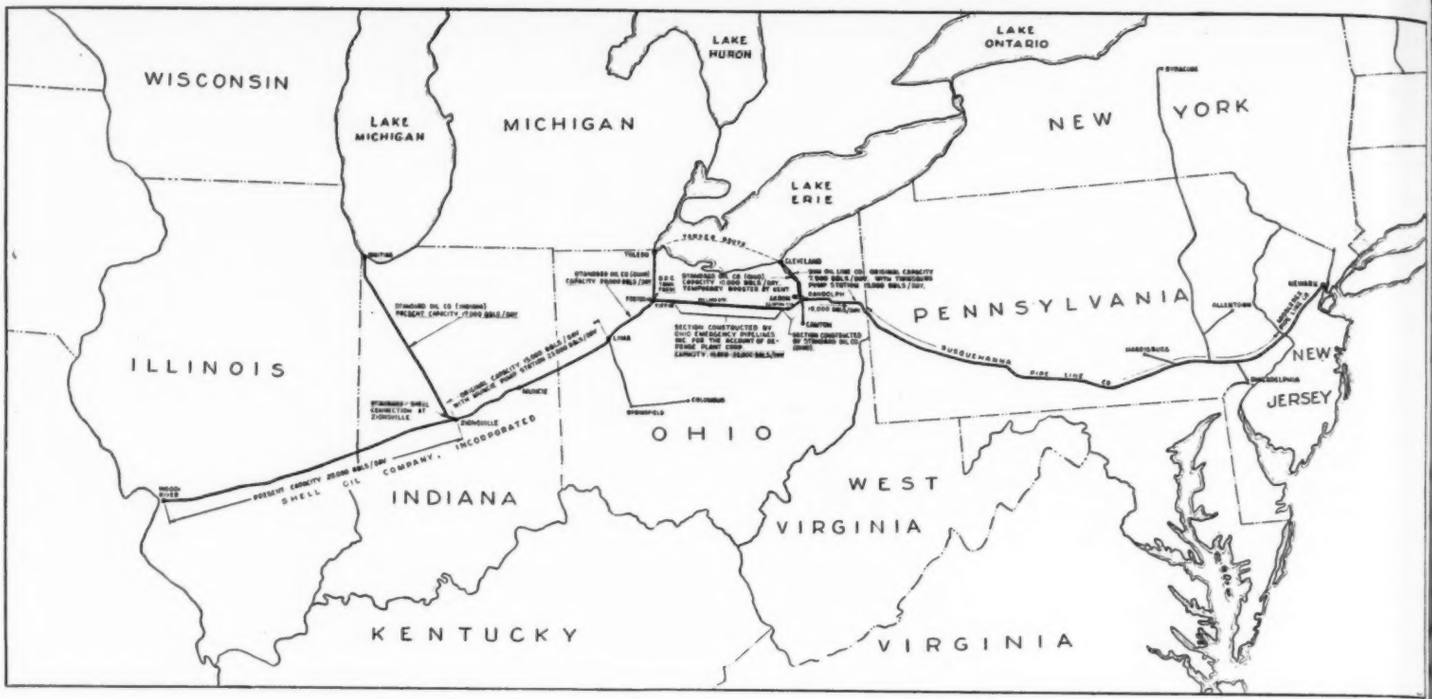
When the work was finished, fourteen new pumping stations were spotted in between the original fourteen main line units, cutting the intervals between stations to 30 miles. They were not the trim steel and concrete buildings which housed the original units, but they were doing their job of pushing the oil along at one and a half times its original velocity.

Last December, before the line was in operation on its expanded schedule, the Plantation Pipeline Company filed with the Interstate Commerce Commission a 25 percent reduction in its tariffs. The line began pumping at its increased capacity of 90,000 barrels a day on February 1st.

Greensboro-Richmond Line Plantation Extension — Unlike the first two sections of Project No. 2, construction of the line from Greensboro, N. C., to Richmond, Va., is being financed by the Defense Plant Corporation at the instigation of the Petroleum Administration for War. It will draw from the Plantation at Greensboro products for delivery to bulk terminals in the Richmond area.

Costing $4,350,000, the extension will consist of 180 miles of 8″ pipe, with a capacity of 30,000 barrels a day. As in the case of the Bayou line, old pipe was used in its construction, as well as second hand pumping equipment. The crews digging up this old pipe hung up some records doing it. On one section they took up 245 miles of pipe in 48 days, or more than five miles a day. But on other stretches they found the going much tougher, with the old pipe buried beneath the frost line, six feet underground.

The design, construction and operation of the combined Bayou and Plantation systems from Baytown and Beaumont, Texas, through to Richmond, Va., is a tribute to the resourcefulness of the pipe line engineers who did the job. More than that, it provides an outstanding instance of constructive cooperation between private industry and government agencies.



PROJECT No. 3

Adds 15,000 Bbl. to Eastward Movement

By Alexander Fraser,
Chairman, Project Management Committee

PROJECT No. 3 in the general program of pipeline revision for increasing the eastward movement of petroleum products, as approved by the Petroleum Administrator for War, is a striking example of the way in which existing facilities have been linked together to contribute to this result with a minimum of new construction or use of critical materials. As described in the recommendation issued by the Petroleum Administrator the project was as follows:

"Construction of a 15,000-barrel per day products line from Fostoria, Ohio, connecting Shell's and Sohio's gasoline pipelines with the Sun-Susquehanna system at Akron, Ohio, for the movement of petroleum products eastward."

The distance included in the route specified above is approximately 121 miles but in the final plan adopted it was found possible to utilize a 14-mile spur line of Standard Oil Company of Ohio from Fostoria to Tiffin and the same company undertook to build for its own account a 25-mile extenion westward from Randolph Station on the Sun's Susquehanna line so that the extent of new construction was ultimately reduced to 82 miles—from Tiffin, O., to the western end of the Sohio extenion. This link, which is known as the Ohio Emergency line, was built for the account of Defense Plant Corporation under a non-profit arrangement by Ohio Emergency Pipelines, Inc., a corporation jointly owned by Standard Oil Company (Ohio), Sun Oil Company and Shell Oil Company, Incorporated.

By this relatively small addition to existing facilities it was possible to knit together a pipeline system extending from the Mississippi to the Atlantic Seaboard which adds 15,000 barrels daily to the deliveries of petroleum products to eastern territory. This is accomplished by utilizing the facilties of the Shell line from Wood River, Ill., to Lima, O., and of the Standard of Indiana's line from Whiting, Ind., to a junction with the Shell line at Zionsville, Ind. From Lima to Tiffin the oil flows through Sohio pipes to the western end of the Ohio Emergency line which then conveys it to the newly built Sohio line already referred to which provides a connection with the Sun-Susquehanna line extending eastward to Philadelphia and New Jersey distributing centers. This involves a reversal of flow in the last named line from west to east. In its completed state this combination line can draw products from refineries at Wood River, Whiting or Toledo. The accompanying map shows the several constituents of the improvised system.

In accordance with the policy of conserving critical materials it was decided to build the Ohio Emergency section of the line of second-hand 8-inch pipe. The letter of intent covering the construction of the line was issued August 28, 1942, but it was not until late in September that a sufficient amount of pipe for construction of the line was obtained through purchase of the Illinois Pipeline Company's Yates-Del Rio line in Texas. As the pipe had to be raised, reconditioned, cleaned and shipped to Ohio, deliveries did not begin until November 10. In spite of unusually difficult weather conditions the line was entirely laid by the middle of January, its one pumping station at Willard, O., was completed and the Sohio eastward extension was ready for use. The only part of the construction remaining to be finished was the tank farm and storage station at Fostoria which is still under construction.

It was not necessary to wait until all these facilities were in readiness to start the flow of products over this system to the Atlantic Coast where they were so urgently needed. Under an interim plan worked out by the managing sub-committee the expedient was adopted during the time when the Ohio Emergency line was being built of routing products through the Shell, Indiana Standard and Sohio lines to Toledo, then transferring them by Lake tankers to Cleveland for delivery to the Sun-Susquehanna line for the remainder of the eastward journey. After the close of lake navigation the movement was continued by using tank cars to replace the water route. The Ohio Emergency line went into operation shortly after January 15.

Under an operating agreement presently being negotiated with Defense Plants Corporation the Ohio Emergency line is expected to be operated under the management of Ohio Emergency Pipelines, Inc., of which Sidney A. Swensrud, Standard Oil Co. (Ohio), is president and a director. Other directors are Norman J. McGaw of Shell and Frank L. Hadley of the Sun Oil Company.

PROJECT No. 5

Expedites Barge Movement of Texas Products

By Eugene Holman,

Chairman, Project Management Committee

THE pipeline system designated as Project No. 5 in the recommendation of the Petroleum Administrator for War in May, 1942, was designed to increase deliveries by barge on the Mississippi and Ohio Rivers and save time and distance involved in the movement of oil from Texas through the intercoastal canal and the low terminals with a total of 752 miles of pipe.

Extending from Port Arthur, Texas, to Helena, Ark., the southern portion from Port Arthur to El Dorado, Ark., was formed by rearrangement and reversal of two existing lines. One of these, an 8-inch line belonging to the Gulf Refining Company and formerly used to convey crude to the company's Coast refinery, was reversed and reconditioned for the shipment of products from Port Arthur to El Dorado, a distance of 324 miles. The other, an 8-inch products line of the Texas Company between Port Arthur and Shreveport was also reversed and by construction of a 15-mile extension from the latter point was connected with the Magnolia Company's line continuing to El Dorado, a total distance of approximately 278 miles.

From the point where these two lines converge Project Five Pipe Line Corporation, which is jointly owned by Gulf Refining Company, Texas Pipe Line Company, Magnolia Pipe Line Company, Premier Oil & Refining Company and Lion Oil & Refining Company, constructed a new 150-mile 10-inch products line to a point near Helena, Ark., on the Mississippi River. The pipe and much of the other equipment used on the line was second-hand material. This pipe was obtained from a 10-inch line belonging to the Gulf and Magnolia companies between Panhandle and Ranger, Texas. The pipe as originally laid was in lengths of 41.85 ft., thread and coupled. When taken up for removal to its new location the threads and collars were cut off, the pipe was beveled and plain end welded to conform to modern practice. The relaid line was coated and wrapped throughout with biturine enamel and asbestos felt and was tested to 1,000 pounds hydrostatic pressure. The route followed by the line traverses much swampy, heavily timbered territory and crosses a number of bayous, creeks and rivers, presenting difficult construction problems but the job was done by Williams Bros., contractors, in three and a half months and completed final test on November 14, 1942. Only one of the four pumping stations was fully equipped at that time but on December 1 when the Helena terminal was ready for partial capacity operation the line began moving 20,000 to 25,000 barrels daily of heating oil and gasoline. As additional stations came into operation the movement of oil gradually increased to its capacity of 55,000 barrels daily. The initial station of the line at El Dorado is equipped with seven 150-HP. Worthington diesel engines direct connected to 5" x 20" horizontal duplex double acting plunger pumps. The intermediate stations have electric motor-driven multistage centrifugal pumps obtained from other pipe line companies. Warren station contains four 6-inch, 5-stage Byron Jackson centrifugal pumps, each driven by a 400-HP, 2300-V, 1750 RPM motor. Each unit has a capacity of 35,000 to 40,000 barrels per day at 375 pounds and in order to be able to pump at full line capacity two sets of units are piped up in series for 750 pounds operating pressure and paralleled for line volume. Star City and DeWitt stations are equipped with two 5-stage Cameron centrifugal pumps driven by 400-HP, 2300-V, 1750 RPM motors piped up in parallel for volume and then piped in series with a 6-stage Cameron centrifugal pump driven by 1000-HP, 2300-V, 1750 RPM motor for line volume capacity.

Besides pumping equipment all pipe, tanks, most of the valves and fittings and a great portion of the buildings are of secondhand vintage. The receiving terminal at El Dorado is part of a tank farm originally used to handle Smackover and El Dorado crudes to the Coast. Old tanks were fitted for use by cleaning, repairing the steel bottoms and replacing old wooden roofs with steel. The tanks at the Helena terminal were removed from tank farms in West Texas and Panhandle districts. Much other equipment was salvaged from various sources and it may safely be said that the line has been constructed and equipped with a minimum of new and critical materials.

One of the interesting features of this line is the river terminal at Helena. At this point there is a variation of about 48 feet between the low and high water level. To deal with this condition there are 21 mooring dolphins each consisting of seven vertical and seven batter piles, spaced for a distance of 2,000 feet paralleling the river bank so that three six-barge tows with two barges abreast can dock at one time. Interspersed are nine loading pipe support dolphins which permits simultaneous loading of full dock capacity.

The dolphins are constructed to an effective height of 50 feet above mean low water level. The loading lines consist of 8-inch line branches from 12-inch main headers located back on the river bank above high water level. These branch lines are laid in the ground and river bank slope, terminating in vertical risers within the support dolphins. There are two 12-inch main headers and one 8-inch branch from each to each support for handling two grades of products. Each vertical loading pipe riser is equipped with five 6-inch plug valve loading hose connection takeoffs spaced to take care of various loading heights, according to the rise and fall of the river. A hand operated crane is provided at the top of each pipe support dolphin for handling the loading hose. There is also a 30-tank car capacity loading rack with switching facilities for loading 60 cars per day.

To indicate the influence of Project Five pipe line on the eastward movement of petroleum products it may be stated that the distance from Helena to Pittsburgh by river is about 1,290 miles, requiring ordinarily 37 days for a trip while the longer water route from Port Arthur would require approximately 52 days. Assuming the full capacity of the line to be utilized this would make it possible to increase deliveries from Texas points to Pittsburgh by 16,000 bbl. daily. Another use to which the line could be put would be to load products into tank cars at Helena. This application may be rather limited but if full capacity were so utilized it would permit a net increase in deliveries into the Atlantic Coast area of 11,000 bbl. daily with a reduction of 80 percent in turnaround time as compared with loading at the Gulf Coast.

Officers of Project Five Pipe Line Corporation are E. C. Kincade, Gulf Refining Co., president; R. B. McLaughlin, Texas Pipe Line Co.; J. L. Latimer, Magnolia Pipe Line Co.; Sylvester Dayson, Premier Oil & Refining Co., and T. M. Martin, Lion Oil & Refining Co., vice-presidents.

The project management committee in charge of Project Five consists of Eugene Holman, chairman, T. H. Barton, J. F. Drake, D. W. Harris, J. A. Brown and H. T. Klein. Members of the engineering committee are C. M. Rosebrugh, chairman, J. E. Howell, G. L. Gano, S. W. Day and Sylvester Dayson.

FIG. 1

Section of Trans-Florida Line with used pipe transferred from Texas.

PIPELINE PROGRAM HAS GROWN

As Need for Facilities Appeared

IN ADDITION to the projects already described in some detail a number of others were covered by the report of the Tulsa conference and by Recommendation 49 of the Petroleum Coordinator. Of these Project 4 was a triple-featured plan for increasing the eastward movement both of crude and products. It included:

1—Expanded deliveries at the port of Buffalo by Great Lakes tankers for transhipment through the New York State Barge Canal. This movement of course is confined to the season of open navigation since this important water route is closed during the winter months.

2—Reversal of the Keystone pipe line between Pittsburgh and Philadelphia from the westward movement of products to the transport of crude to Philadelphia. This change was carried out by the owners of Keystone, the Atlantic Refining Company. Reversal was completed May 22, 1942, and the reversed line is delivering 24,000 barrels daily.

3—Construction and subsequent reversal of the Sinclair Pipeline for products between Steubenville, Ohio, and Philadelphia. Full operation of this carrier is expected in April when pump stations at Steubenville and Florefe, Ohio, and a terminal on the Ohio River are completed.

Delays in delivery of materials and extreme winter weather which retarded completion of the pipe-laying job have extended the effective operation date of this line. It will be capable of a 15,000 B/D movement of refined products when in full operation.

A few other projects covered by Recommendation 49 subsequently were dropped or temporarily set aside but with the exception of these inactive plans the preceeding discussion outlines the general disposition of the pipeline proposals originally contemplated by the Tulsa conference and subsequent official establishment of those recommendations as projects of the Petroleum Administration for War.

The program thus initiated set an overall pattern for expanded pipeline runs to the eastern seaboard. It was comprehensive—not final.

Even before it was substantially under way, the growing uncertainty of ultimate war demands, combined with more readily forecast requirements of war industry and basic civilian uses, caused the construction of additional pipelines and the adjustment and extension of existing or projected facilities to be regarded as imperative.

Pipeline Projects Nos. 12, 13, 14, 15, 16, 17, 18 and 19 represent the enlarged pipeline attack on the petroleum transportation problem.*

Project 12, first of the additional proposals to receive official sanction, is better known as the Trans-Florida pipeline. It links the eastern end of the Gulf-Intra-Coastal Waterway with the Atlantic Intra-Coastal Waterway and permits an enlarged barge movement of gasoline to points up and down the coast from the Atlantic terminal of the line.

Physically, the Trans-Florida Pipeline is the American Liberty Pipeline transferred from East Texas to the new Carrabelle-Jacksonville route. Built almost entirely of used materials the line is designed to move 35,000 B/D of petroleum products and will be fed at Carrabelle terminal by barge movements from Texas refineries. Construction work is now virtually completed and the line is scheduled to go into operation during the current month.

Project 13 covers construction by the Sinclair Company of a 149-mile 8-inch crude oil pipeline from Corpus Christi to Damon, Texas. The purpose of this line is to insure adequate runs of Texas-Gulf crudes to Houston refineries for the manufacture of war products and to replace East Texas crudes diverted from the area to feed the War Emergency Pipeline at Longview, Texas. The capacity of the line is 20,000 B/D.

As of April 1, 1943, the line is completed and in operation. Tankage facilities at Damon are practically completed.

Project 14 provides for the construction of a 266-mile eight- and ten-inch pipeline from Paradise, La., to Port Neches, La., for the movement of both crude and distillates. This, for the movement of both crude and distillates. This, the only pipeline is the entire program whose effective flow is westward, is designed to provide in the Gulf Coastal refining area additional quantities of special crudes for war products refineries. While this is the basic justification for this new facility, it will have the correlative effect of releasing crudes available at other sources for transmittal eastward either by pipeline, barge or tank car.

Initial operations were begun at a rate of approximately 14,000 B/D. Throughput is being stepped up periodically as additional pumping stations are completed. Total pump stations will be ten and it is expected that the line will be in full operation at a capacity rate of 40,000 B/D before the end of April.

Project 16 does not lead directly to an enlargement of the movement of petroleum products into District 1, but has a collateral effect by increasing the volume of products carried by the Great Lakes pipeline system. It involves construction of a 55-mile, 6-inch pipeline for petroleum products from the Cushing-Drumright area to Barnsdall, Oklahoma, and enlargement of the Great Lakes Pipeline and connecting lines.

The chief benefit of enlargement and integration of this pipeline facility will be the release of other facilities for the movement of necessary fuel oils and gasoline to more critical areas.

The new pipeline is completed and in operation. The Great Lakes Pipeline Company is enlarging the capacity of its system to handle the additional products received at Barnsdall. Enlargement consists of the construction of eight new stations between Kansas City and Minneapolis. Five of these, north of Des Moines, Iowa, have been completed and the remaining three stations, located south of Des Moines, are scheduled to go into operation around April 1.

Embraced in Project 16 is the conversion of a 14- and 16-inch natural gas line between Refugio and Pierce Junction, Texas, and the extension of this facility by the construction of a new 12-inch line to Houston.

The objective of this conversion and construction job is to provide 75,000 B/D of Southwest Texas crudes to Houston and Port Arthur refining centers, and to permit delivery of additional quantities of crude oil to the War Emergency Pipeline feeders at these points. Completion of this pipeline is scheduled for May 1, 1943.

Project 17 includes the building of a new crude line from Houston to Huffman, Texas, and the reversal of an existing pipeline from Huffman to Smith's Bluff, Texas, by the Sinclair Company.

The new 25-mile, 12-inch pipeline between Houston and Huffman parallels an existing Sinclair line and permits the northward movement of crude along the established right-of-way.

The reversed 67-mile, 8-inch pipeline between Huffman and Smith's Bluff will be freed for the movement of about 25,000 B/D of Southwest Texas crude to Smith's Bluff by local pipeline extensions at the Huffman station. Connection at Smith's Bluff with the reversed Atlantic pipeline permits continuous movement to the War Emergency Pipeline at Longview. Completion of this project is expected by May 15.

Construction of a crude oil pipeline system from Southeastern Louisiana fields to the Baton Rouge Refinery of the Standard Oil Co. of La. is prescribed by Project 18.

The crude oil thus delivered at Baton Rouge will further insure adequate supplies of crude oil runs for the manufacture of war products.

When completed, by or about May 1, this project will carry 15,000 B/D of crude previously transported to Baton Rouge by barge. The release of these barge facilities will have the complementary effect of permitting an increase in the barge movement of petroleum north and east on the Mississippi and Ohio Rivers, or for shuttle service on the Gulf Intercoastal Waterway.

Enlargement of the Stanolind pipeline between Mexia, Texas, and Humboldt, Kansas, is provided for by Project 19. By laying additional loops and increasing the pumping capacity of stations an additional 18,000 B/D of crude oil will be made available in the Kansas refining area.

An aggregate of 139 miles of 8- and 12-inch loops will be laid. In general materials will be salvaged from other parts of the Stanolind system. Project completion is set for the month of April.

Acknowledgment

In preparing the comprehensive presentation of changes in oil transportation routes and methods resulting from the war, WORLD PETROLEUM is indebted to many organizations and individuals concerned in this remarkable transition. While it is impossible to make acknowledgment to all of these the Editors desire to express their appreciation of special assistance rendered by the Offices of Petroleum Administration and Defense Transportation, the Association of American Railroads, the chairmen of the various pipeline project committees and particularly by Mr. D. F. Leary of War Emergency Pipelines, Inc.

* Projects represented by the "missing" numbers, i.e., 7, 9, 10 and 11, are ones that have been considered and either abandoned or are currently in abeyance.

Old Man Winter holds no terrors for these veteran pipeliners.

MUD, MOUNTAINS and WINTER

Test Mettle of Veteran Pipeliners

By Ike McAnally

WINTER work on the eastern leg of the big oil pipeline from Texas has been handicapped by numbing cold thawing to sticky mud and freezing back again, a dramatic, obstructing routine.

That winter hardships might threaten to throw the progress of the operations out of step with optimistic predictions was a possibility foreseen by W. Alton Jones, President of War Emergency Pipelines, Inc., as well as by Harold Ickes, Petroleum Administrator for War, and by the veteran pipeliners themselves.

All hands met the challenge doggedly, determined to battle the line through come snow, come sleet, come frost, come thaw, come hell and high-water with a thick sheet of ice on top of it all.

A pipe foreman put it into words. Two of his boom cats had been knocked out and still the steep Pennsylvania foothill, thawed to a morass of mud and ice defied passage. The foreman scratched his head and re-studied the problem.

"We can't put the line up that hill," he drawled. "Not on purpose, we can't. But, by God, we're going to *accident* her up there!"

That pipeline went over that hill. And that very day. By dark it was aimed point-blank at the next horizon. Men with a casual contempt for personal danger, men with a casual pride in their work, had "accidented" the big pipe line up another Pennsylvania foothill.

Twenty miles up the right of way, another spread of men were "accidenting" the Big Inch through other foothills so slippery that a man could hardly stand on his own feet, and the big D-8s had to work in pairs so they could wench each other forward. And all this in weather uncomfortably bitter even to a man tightly bundled.

A cat skinner came up to Pennsylvania from Texas where he had been working on a small line.

"Heared you old boys wus a'havin' tough goin' up here," he drawled.

"Not too rough," replied a foreman who knew the skinner and wanted him badly.

"I heared," persisted the cat skinner who had been listening to the grapevine, "I heared that one cat skinner wus killed and that a whole lot of 'em has almost been killed in these badlands."

The foreman had to admit that the going was very dangerous for caterpillar operators.

"You know," drawled the cat operator, "I jes' think I'll set in."

That is how another pipeliner had been tempted beyond his strength by the beckoning adventure of the Big Inch and as a result had decided to drag up from an easy job in warm weather and come up north and "set in" on the Big Job.

At noon on March 2, the Big Fellow was peering with his cycloptic eye over the top of the Tuscarora mountains in Pennsylvania and in fifteen minutes he was heading down the other side with forty-foot stalks, which is what the "mainliners" call joints.

In a short time he would be looping over the Alleghenies, driven forward by the expert and determined hand of men who have eyes set on the next mile, and the next.

The mainliner takes a live pride in his calling which in some instances amounts almost to temperament.

Out on the job they tell the story of a mainliner who along with his fellows was wallowing around in mud almost knee deep and making shamefully slow progress. In the home office of the contractor, an executive fretted at the delay until he could stand it no longer — he went out on the job to see what the hell. In hip boots he strode out on the right of way and accosted the mainliner who was leaning on a shovel with which he had been cleaning off the digging wheel, or stinger, of the big mucker.

The executive was not in his best humor anyhow and he turned on the mainliner and demanded to know why the blank-blank he stood leaning on that blank-blank shovel.

"Mister," drawled the mainliner, "I don't know what part you play around here, but I'm dragging up." Whereupon he laid the muddy shovel across the outbended forearms of the executive and walked off the job.

The executive went to the spread foreman.

"It's bad enough to have words with one of the men," the executive admitted, "but I can tell you that it's even worse to be on the receiving end of words you can't even understand."

The foreman explained that what the mainliner had meant to tell the executive was that the mainliner was quitting.

Incidentally, the mainliner went down the line a few miles and sat in with the next spread because he was a good monkey. Several days later the foreman of the first spread met him "accidentally" in a nearby town and got him back. That's the story, anyhow. And if it's slightly tall, it comes from a tall story clan.

It comes, too, from a bunch of men who know that the hardships of their profession sometimes stretch a man's nerves taut and to them it is perfectly permissible for that man to pop-off. But always provided the man is a credit to the profession of pipelining. Let a man pull temperament without having won by superhuman working effort the respect of his fellows and it is likely that he will never reach the point where he can sing an executive out as they say out on the line. He would be "run-off" the job.

For it is the sober truth that on the winter operations on the eastern section of the line, pipeliners have undergone and mastered hardships and work problems and in doing so have added much to their pride. They have done the job to their satisfaction — and they are men hard to please when it comes to the way they meet the demands of their work.

In spite of the worst weather in years — in

The operator always sticks with his cat; an unwritten law of the pipeliners.

decades, even — the men have laid that big pipe and are laying it, day in and day out, meeting new problems and mastering these problems with new techniques.

A tow cat got bogged on one of the western slopes of the Alleghenies. The skinner tied on to a tree in an effort to wench his cat out. The tree came up by the roots. He tried another tree and it also pulled out.

The tow cat operator got himself a shovel and a "dead man" and went up on the hill and, after tying his tow line to the "dead man," buried it deep into the ground. He went back, got in the seat of his cat and said, out loud:

"I'll just pull the damn hill out of the way."

Instead he pulled his own cat out of the bog.

Up to the time the pipeliners got into the eastern hill country, it had been considered very bad manners for a cat skinner to leave his machine, no matter how wild it got to running. In Pennsylvania, a skinner got killed when his caterpillar fell down a mountain side with him and the other pipeliners tried to persuade the cat operators to abandon the unwritten law that a man must stay with his cat. But the cat operators very quietly refused. It is still not considered in the best tradition for a cat operator to jump from his machine.

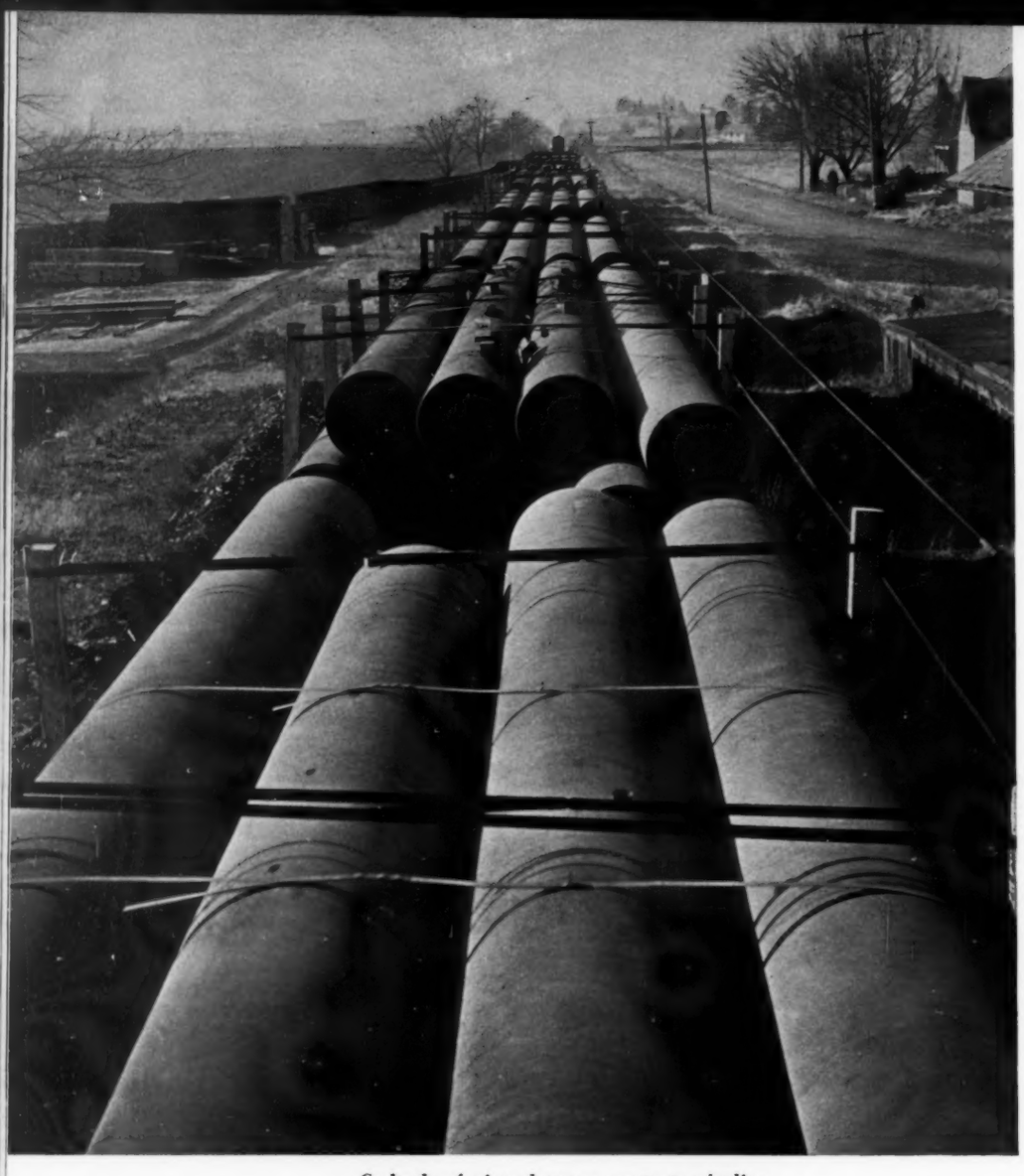
These have been the isolated incidents which go to make up the overall picture of the winter pipeline operations. They are typical of what has gone on. The going has been hard; the men even harder. In Ohio, the special correspondent for WORLD PETROLEUM got to talking with a hard knot of a little man who had been pipelining for twenty years.

"Is this the toughest job of pipelining in all the history of the business?" the correspondent asked.

"Yep," the little pipeliner said. "I've been everywhere a line was being laid — and I mean everywhere, including even the Middle East. I never saw anything like this." He waved his hand at the equipment which had been knocked out, and was still on the right of way being repaired. "You know, it is so bad that I suspect we're going to be a few days late in finishing this leg of the job. Maybe two or three or something like that." He didn't crack a smile.

And already the men are talking about setting in on the second mainline.

Rugged mountains, deep winter snow and mud are some of the obstacles to be overcome by the pipeliners in pushing the Big Inch over the Alleghenies.



Carloads of pipe shown en route to pipeline.

PIPE FOR THE "BIG-INCH" —A Train Load a Day

WHEN the complete story of the industrial miracles worked in the course of America's war production is finally written, the full significance of the oft repeated phrase "the men behind the men at the front" will come into its true perspective. For back of these achievements in production is a fascinating story of men and machines working as they never worked before. It is a story of equipment pushed to the limit of its capacity with mighty little time out, and a story of grim determination to hasten the day of victory by sweat and toil and sacrifices along every production line.

Manufacturing pipe for the "Big-Inch" line is one of these production miracles. Before a single length of this pipe was made, a carefully planned and integrated program involving men, materials, machines, and every facility for its fabrication and delivery was worked out. So effectively were the different procedures coordinated that the final length of pipe for the first unit, involving a total of some 70,000 separate lengths and 124 working days of 24 hours' operation, was completed within the hour originally set for the finishing of this enormous undertaking.

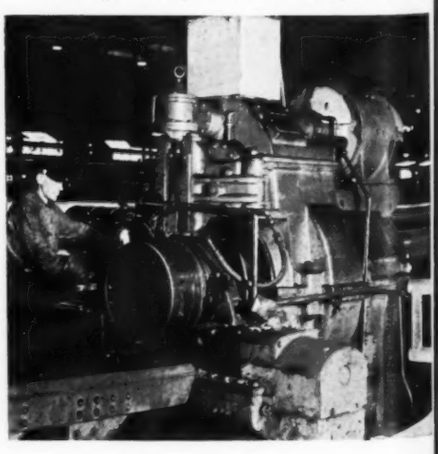
Two outstanding features highlighted this achievement: first, the maintenance of an unbroken supply of solid rounds of steel at the initial heating furnaces ready for piercing; second, the continuous movement of every length of pipe through the various operations inside the plant and on through to the loading and a train-a-day-makeup in the yards, without a serious hoidup during the entire run of the line.

Some idea of the tremendous task involved in producing the longest and largest oil conduit ever built may be gleaned from the fact that each length of pipe is 24 inches in diameter, averaging 41 feet in length and weighing approximately two tons. This weight, however, represents but a relatively small proportion of the combined weight of all the materials that are necessary to produce but one of these lengths. Ton after ton of iron ore, limestone and coke enter into the making of the steel required for each piece of pipe.

This steel is made by the open hearth process in large unit quantities, a hundred tons or more in a batch. It is tapped into ladles which convey the hot metal to the pouring platform where it is teamed into molds to form ingots, each of which weighs approximately 11 tons. The ingots, stripped of the molds, are placed in heating or soaking pits to bring them to the proper rolling temperature. They are then rolled into rectangular blooms and, without reheating, are converted into round billets in the bar mill. Following this operation they are sawed into billets or "rounds" of proper length. This is the form in which the steel stock is delivered to the pipe mill. These rounds measure a foot in diameter, twelve feet in length and contain sufficient metal to make one length of finished pipe. Previous to their delivery to the pipe mill, however, each billet has its entire surface or skin removed to a depth of approximately one-sixteenth of an inch, in a giant peeling machine, after which any surface defects are removed by chipping. Following this thorough "conditioning" the billet or round is ready for the actual pipe making processes. At this point it is interesting to note that the cycle of operations from iron ore to finished pipe requires approximately 72 hours.

It is in the pipe mill department of the world's largest plant of its kind that a truly dramatic story unfolds with a scene of charging the solid rounds into the heating furnaces preparatory to their journey through the seamless mills. Only highly skilled workmen, specially trained in the art of heating steel, are allowed to guide them through this critical stage of tube making to be sure they are "just right" for the all-important

Cutting off and end beveling—one of several finishing operations on "big-inch" prior to final test and inspection.



operation next to follow. When it reaches the proper forging heat, a round is pushed into the rear of the piercing mill where it is gripped between powerfully driven rolls and forced over a mandrel held between them. There takes place the dramatic and somewhat mystical transformation of a solid mass of steel to a hollow seamless forging; it is here that "life begins" for the "Big-Inch" pipe.

As the hollow billet emerges from the piercing mill it is a relatively thick-walled tube, somewhat rough on the surface but fairly uniform as to wall thickness. This first piercing is followed immediately by a second similar operation where the wall thickness is reduced and diameter and length are somewhat increased. Here another interesting observation is made; the piercing operation is perhaps the most crucial test that any steel is required to undergo in the process of initial fabrication. The tremendous power driving those mighty rolls that force the metal over and around the mandrel, forming the wall of the tube, is drastic treatment for any material. Billets passing this test must be of fine grained homogeneous steel

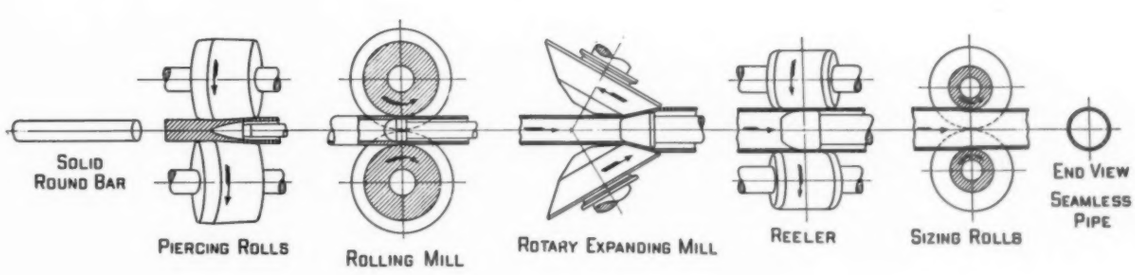
At this stage of its development the rough tube is rather short because of the thickness of its walls, and the next step is to increase its length by reducing the wall thickness. This is accomplished by rolling the slightly reheated tube in two passes, through grooved rolls over a plug held in the roll groove on a bar. The requirement now is to increase the diameter. The rolled tube is immediately reheated and transferred to the rotary expanding mill. Here it is gripped by a set of conical disc rolls, rapidly rotated and rolled over a tapered mandrel between the revolving discs. Thus the diameter is greatly increased without much change in length.

At this point the tube or pipe is very largely made so far as length, diameter, and approximate wall thickness are concerned. That is, in form the pipe is there, but other important operations are necessary before it is finished.

Piercing the solid billet of steel—the heart of the seamless process. It is here that life begins for the "big-inch."

From the rotary expanding mill the pipe is conveyed through the breakdown sizing machine to the reelers. Here it is reeled between cylindrical rolls and over a plug, so that any surface irregularities are removed and the pipe is given a smooth burnished effect, both inside and outside. While not essentially a spectacular operation, reeling is a very important step in pipe making. Obviously a high surface finish reduces interior friction and facilitates exterior protection. After being reeled the pipe is passed through a reheating furnace and into the sizing machine where uniformity of size or circularity is produced. Perfect uniformity is extremely important in making up joints in the field; in fact it is a prerequisite to the smooth and exact lining up of pipe lengths end to end and in the actual finishing of the joint.

SEAMLESS PROCESS*



* For brevity, certain operations are not illustrated, including a second operation similar to piercing rolls shown.

Some of the workmen who man the principal operations in making the "big-inch" pipe: John Ivancic, heater, John Stuowski, piercer plugger, Irving Higgins, Hi-Mill roller, Steve Pastor, rotary roller, Anthony Aleskin, Reelerman, and Matt Pozega, straightener.

The next and last basic operation is straightening. For this purpose a specially designed rotary straightener is used to give uniform straightness to the pipe from end to end.

Following these fundamental operations the pipe moves to the finishing department. Here, after a preliminary inspection, each end is cut off, leaving a smooth machine-finished edge which is beveled to 30 degrees to facilitate end welding in the field.

From the cutting-off machine the pipe passes to the testing operation where a hydrostatic test is given every length, after which it goes to the inspection table where a final and rigid inspection is given, including gauging for proper wall thickness and roundness of the section. In its earlier progress along the production line, the results of successive operations have been carefully observed. As a consequence, at the final inspection the turnbacks are remarkably few considering the many thousands of lengths passing through.

After the necessary stamping and stenciling have been done, the pipe is loaded into cars, which in turn are assembled into trainloads ready for the journey to designated places along the line. Some idea of the loading and car handling problems on a job of this magnitude can be gained from the fact that pipe for the first unit of the "Big-Inch" line was produced at the rate of five and one-half miles per day, or 1,375 tons, making a trainload of forty-five cars a day.

No word description of the processes by which rough ingots are transformed into finished tubes of polished steel can convey the impression of resistless and undeviating power imparted by the huge mills and rolls as they carry on their tasks, almost automatically it seems, of turning out completed lengths of 24-inch pipe at the rate of one every two minutes. Back of the machines, however, and responsible for their astonishing proficiency are the heaters, pluggers, rollers and reelermen, the men who know steel in all its moods and phases, whose experience and judgment keep the pipe coming, perfect in its dimensions and in conformity to the standards set for it.

The main line pipe for the first log of the "Big-Inch," from Longview to Norris City was turned out by the Lorain plant of National Tube Company, the largest seamless tube mill in the world. The production schedule laid down at the commencement of the work was followed without a break and deliveries of the pipe were spotted along the 550 miles of the route according to the timetable adopted with such regularity that no section crew was delayed for a single hour by lack of material in its task of welding and laying the line. The entire operation was not only an outstanding achievement in production but a triumph of organization for which men, machines and management share the highest measure of credit.

When it was decided to push the War Emergency line eastward from Illinois to the Atlantic Coast the mill continued its task of turning out pipe for the eastward extension without a stop. Throughout the winter months this pipe has been moving forward steadily by the trainload, across Indiana and Ohio, over the mountains of West Virginia and Pennsylvania and on toward the eastern seaboard. It's a big job, the biggest of its kind ever undertaken, and the speed and efficiency with which it has been performed adds a bright chapter to the record of America's war production.

Here then we have seen the "Big-Inch" come into existence; raw materials and ingredients drawn from widely different sources; machines and equipment groomed for a giant but precision-like job of unprecedented length; workmen and supervisory staffs primed with every known safeguard for smooth, continuous performance, the whole blended into one master effort of coordination appropriately labeled "It can be done".

As long as native ingenuity is free to marshall its own resources, by drawing generously upon the experience of the past and by blending therewith the typical Yankee trait of tackling big jobs in a big way, so long will production miracles continue to adorn the pages of industrial history, and so long will America remain strong and safe.

National Tube Company executives who negotiated the order for the "big-inch" line and accepted the responsibility for delivery of the pipe in record time: left to right, John E. Goble, vice president in charge of sales, W. F. McConnor, general manager of sales, and Charles R. Cox, president.

All welds are double coated and cigarette wrapped with a second shield of asbestos felt. Photo Courtesy The Barrett Co.

CORROSION From The Viewpoint of Management

By Starr Thayer
Consulting Engineer

IN THE PAST many articles have been published on the mechanics of eliminating soil corrosion of pipe lines. This subject has been thoroughly discussed at many of the national meetings of the oil and gas associations and at the soil conferences of the National Bureau of Standards. Without going too much into the technicalities of all of the many phases of the causes of corrosion and the remedies, a study of this subject from the executives' viewpoint has been suggested.

The loss of metal due to soil corrosion is the one main factor that determines the life of a pipe line. It can also be the cause of most of the maintenance cost on the line. To make it still worse these losses are highly unpredictable. The study of corrosion on pipe lines surely deserves all of the attention that it has received.

Some one in authority must decide what the policy of the company will be in combatting these losses. In general he is confronted with two problems: What to do to mitigate the losses on existing lines and what should be done in the way of protection in new construction.

Until a few years ago we had but one recourse in stopping losses on old lines; that was to renew the pipe. The development of cathodic protection has been a life saver on these lines. Without going into details, we may explain that in this system the pipe line is made negative or cathodic to the surrounding soil and if it is sufficiently so corrosion will cease. This system has been in use for several years and proved its efficiency. Some companies with thousands of miles of pipe lines have been able to eliminate the renewing of pipes.

It is now possible to fairly accurately determine the cost of installing this protection on a line. Operating costs can also be closely estimated. With this information the management must decide whether it will be best to use this protection or to recondition the line, or both. In general it will be found that large gas lines may most economically be saved with the cathodic protection. Oil lines may be reconditioned with less cost than gas lines. They can be worked on while the line is in service and therefore it is not necessary to lay a new line before taking up the old one as is the case with gas lines.

It is evident that there are cases where the cathodic protection would not be practical. This would be the case with a very short section of line or a line of very small diameter that was easily reconditioned. It must be remembered that the cathodic protection will not replace any metal onto the pipe. Therefore if a line is in such a state that it will not carry the pressures desired this protection would be of no value.

As said before, some one with authority must decide what policy shall be followed. Knowing the cost of renewing or reconditioning the line and knowing the cost of the cathodic protection, it should not be hard to reach a decision. Having made the decision as to what to do the question then arises as to when to do it. It is evident that if it is planned to recondition the pipe it should be done while the pipe is still worth saving. The pipe could be allowed to reach such a state that the cost of repairs would approximate the cost of new pipe. If the cathodic protection is to be used not much is gained by postponing its installation until the last minute. It is the practice with some companies to apply this protection as soon as it is evident that trouble may

be expected within a reasonable time. Others have waited until repairs have become a burdensome expense. Some one must make this decision.

We have discussed how to meet these problems and when to attack them. Perhaps a word as to where to look for them would be opportune. Naturally corroded pipe will make itself known if we wait for leaks to indicate the trouble. This may be too late in some cases. At least one method has been used with success to determine where the most corrosive spots are on a line. Knowing where to look for suspected trouble it is an easy matter to examine the pipe in a few places and determine its condition.

Much has been accomplished in the last few years to aid the operator in keeping his lines in service at a minimum of cost.

When designing a new pipe line it is common practice now to plan against future corrosion troubles. In planning this protection the engineer is confronted with a long list of questions, many of which are not easily answered. If he applies a protective coating to the entire line, in the case of a long line, he may be accused of wasting money by not classifying the soils as to their corrosiveness and using the coating only as indicated by these tests. If he attempts to classify the soils and coat accordingly trouble may develop later in unsuspected areas.

There are several factors that determine the importance of guarding against corrosion losses. On a small line it is evident that troubles would not be as serious as with a large line. If the line is to be laid in a sparsely settled area leaks would not be as serious or as costly to repair as in a thickly settled area or one of rich agricultural fields. In a line carrying fresh water leaks would cause but little damage whereas a leak in a gasoline line could cause a large loss of valuable liquid as well as creating a public hazard. In cross-country lines oil leaks often result in considerable crop damage but gas leaks seldom cause any such damage. If the line is to be of a temporary nature less care is necessary than with one built for permanancy. A consideration of these factors will determine just how much importance to give to this part of the design.

If it is planned to design a corrosion free line the engineer, and for that matter the executive, is confronted at once with one very important problem: That is whether to apply a coating to the entire line or attempt to classify the soils.

A great amount of study has been devoted to classifying soils with respect to their corrosiveness. The results have not been very satisfactory. They have been classified as to moisture and oxygen content, as to electrical resistance, and acidity.

It would seem that the moisture content would be an excellent measure of corrosiveness, but such is not the case. As an example, lines laid in fresh water streams seldom give any trouble except at the water edge. Some of the areas of the middle west where there is considerable rainfall are very easy on pipes. On the other hand, extensive areas in West Texas and the Rocky Mountain states, where rainfall is not enough to support vegetation to any extent, are very severe on pipes. The writer has seen lines that were suffering considerably from corrosion in areas where the yearly rainfall was less than three inches.

It was thought for some time that the electrical resistance was an accurate measurement of corrosiveness of soils. It is accurate only to this extent: It will identify the very corrosive soils and the extremely non-corrosive soils. However both of these are identified by visual inspection. Probably close to 90 percent of the soils fall outside of these limits and in these soils there is little if any correlation between resistance and corrosion. The same is true to some extent with the acidity measurement. Rogers® has found that there is little if any correlation between acidity content, as measured by the PH, and corrosion.

Probably one reason for the lack of correlation in these tests is the lack of uniformity of the soils. A soil could be very bland, or easy on pipe, and all of the above tests would so indicate it, and still severe local corrosion could de-

W K M cleaning and priming machine shown in operation. Photo Courtesy The Barrett Co.

Applying wrapper preparatory to laying pipe. Photo courtesy Philip Carey Co.

velop. This occurs frequently. This is caused by small clods of a different soil type which escaped the test. One example of this would be a few cinders in the soil. Where one of these came in contact with the pipe corrosion would develop rapidly and yet all tests would indicate a bland soil. The same holds true with small bits of gypsum, and to a lesser degree, several of the clays. Denison and Darniele** of the National Bureau of Standards prepared a paper in which this was very ably described. (Research Paper No. RP1157.)

The most accurate method of classifying soils is to identify them with soils in which pipe line history is known. The history of lines in the immediate vicinity is highly useful in this connecton. Some care should be used here however. If the new line is to be of a larger diameter, and therefore laid deeper, tests should be made to see that the same soil conditions prevail at the lower depths.

It is somewhat discouraging to find that there is no method of taking test data that will accurately predetermine the life of a pipe line if laid bare.

If the management is satisfied that the potential corrosive areas have been defined it may be decided to coat these areas and leave the rest bare. Here again caution should be used. These areas should not be too closely defined. Coating a few hundred feet here and there can, and probably will, lead to trouble later. Corrosion seems to concentrate at the ends of the coated sections unless these sections are carried well back into the areas of good soil.

This is best illustrated where reconditioning of local "hot spots" has been done. In this case all pipe showing the effects of corrosion was cleaned and well coated. Within a very short time corrosion troubles developed immediately adjacent to the ends of the coated sections, where there had been no pitting previously. This same condition could easily develop on new lines.

All of this might indicate that the writer would frown on laying bare lines or even attempting spot coatings. Such is not the case. We merely wish to emphasize the care that must be taken in carrying out such a program.

Reference has been made to protecting pipe lines with coating materials. If steel or iron is used underground and in a corrosive soil it must be protected or losses will occur. There are no ferrous materials that have any worthwhile advantage over common steel in resisting corrosion by soils. Neither is it economical to lay extra thicknesses of wall to combat corrosion. Steel is a very poor and very expensive pipe coating material.

The coating of new lines has become a highly skilled art. It is no longer necessary to gamble with coating materials. There are many on the market with several years of satisfactory history. In recent years very pronounced improvements have been made in the application of coatings. Machines such as the one illustrated can apply some miles of coating per day to pipe that is all welded up and ready to lower into the ditch. Electrical detectors are available that will find faults in the coating that are too small to be seen or that may be covered up with the wrapper. It is little wonder that there has been a tendency to coat all pipe regardless of soil conditions.

Inspector looking over completed operation. Inspection foot by foot by field service men and War Emergency engineers was a notable feature of the Big Inch line.

There is this much to say for entirely coating a line: It does remove any gamble that might be otherwise incurred. Even if a few faults or fractures occur in the coating material it is not serious. At a very minor expense cathodic protection could be applied to such a line and all chance of corrosion losses would be eliminated.

A very large percent of the steel that is made in this country every year is used to replace metal lost by corrosion. The pipe line industry probably uses more than any other industry for this purpose. Hitler's best ally is corrosion.

Coating machines and kettles travel along line in tandem. Enamel is transferred from kettle to enamel reservoir of coating and wrapping machine.

* Walter F. Rogers, Gulf Pipe Line Co.
** Irving A. Denison and Robert B. Darniele, National Bureau of Standards.

Tanker L. S. Wescoat at shipyard on Great Lakes.

MILLION BARRELS OF OIL

Move Daily on Inland Waterways

River, Lake and Canal Routes Combine With Rail and Pipe Lines to Speed Eastward Movement of Petroleum Products—Extensive Barge Construction Program Under Way.

STEADY PROGRESS on the inland barge program, with a total of more than 1,000,000 barrels per day of petroleum and petroleum products being carried on all inland waterway routes and with additional new equipment being placed in service, was the mid-March report of the Petroleum Administration for War and the Office of Defense Transportation. Federal officials express themselves as satisfied that existing inland waterway facilities in connection with all other methods of overland petroleum transportation, are being used to the maximum in augumenting East Coast supplies.

Through a careful scheduling of river and canal traffic, improvements to waterways facilities, expansion of the barge construction and conversion programs, and through efficient coordination of water transportation with the rail and motor systems which carry petroleum to its ultimate destinations, the exceptional demand that fell upon the railroads when the war disrupted the coastal tanker service has been eased materially. It is hoped that the present average delivery of 1,000,000 barrels per day by inland waterways will be increased during the summer of 1943 with a corresponding increase in East Coast receipts. Prevalent opinion both in PAW and ODT, however, apparently is that the best way to accomplish this result is to concentrate efforts toward the expansion of water-borne traffic on interior river and canal routes where conditions are the most favorable rather than to attempt to establish barge transport direct to North Atlantic ports. The latter course, it is pointed out, would involve delay and require much new construction. The reason advanced by the two government transportation agencies for concentration on deliveries to points in the central states rather than the North Atlantic area is a simple one. The time required to transport oil by towboat and barge can be utilized better in those sections of the country where river traffic is an important part of the general transportation system; little can be gained by trying to extend barge shipments into areas where railroad tank cars can pick up oil shipments and deliver oil with a 24-hour turn around to points which would require several days turn-around for a barge.

Saving of time means more efficient use of equipment and this is a primary objective in the emergency movement of oil. For example, although through barge service is possible via the Mississippi and Ohio Rivers, from New Orleans and intermediate ports to Pittsburgh, valuable time can be saved by transporting petroleum products only part way by barge and the rest of the way by tank car. Oil carried up the Mississippi and Ohio as far as Cincinnati and trans-shipped by rail to an eastern point, let us say Boston, requires only 30 to 36 hours more for a tank car than if shipment were made from Pittsburgh by rail. By using barges on the Cincinnati-Pittsburgh portion of the route, the excess turn-around time on the barges would be nine days.

Traffic on the Gulf intracoastal waterways, the Mississippi River system, the Hudson River, the

New York State Barge Canal and other important inland water routes, will be intensified as an extensive conversion program involving the rebuilding of steel dry cargo barges into petroleum carriers progresses. This program, undertaken under the joint auspices of ODT, PAW and Defense Plant Corporation, now is turning out approximately 30 barges per month using only about 10 percent as much steel per barge as would be required for new construction. According to a report of the sub-committee on petroleum of the House Interstate Commerce Committee, 259 steel barges can be transferred from other cargo service and converted in this manner.

The government's present program contemplates the construction of 100 steel tug boats, each to be powered with 600 h.p. Diesel engines, and 21 steel towboats, steam-propelled, of 2,000 h.p. each. Construction of 500 wooden oil barges of which 300 already are under contract to private contractors under the supervision of the Corps of Engineers, U. S. Army, also is contemplated, although shipping men in general disapprove of carrying petroleum in wooden bottoms. This wooden barge construction program was made necessary, however, by a shortage of steel, and every care will be taken to use the wooden barges only for carrying residual fuel oils. Even then such wooden barges will be kept away from canalized rivers to minimize damage to navigation structures in case of fire. Their operation, of necessity, will be in accord with the strict regulation of the Bureau of Merchant Marine Inspection. At the present time, about 1,300 barges are in use as petroleum carriers on the inland waterways. Of these, more than 90 percent are of steel construction. At present wooden barges are not used for the ultimate delivery of petroleum except in the Gulf Coast area.

Development and expansion of inland water routes appears to have reached a point where further efforts to open up possible canal systems appear to be neither economic nor feasible. The question, however, has stirred up considerable controversy in Congress and in the press, particularly with regard to the proposed Trans-Florida Canal. Regardless of the outcome of this Trans-Florida Canal controversy, usable waterway and transportation facilities are available now via the Gulf Intracoastal Waterway, from Houston, Texas, to Carrabelle, Florida. By the end of 1943 it is hoped that this waterway will be completed from Houston to Corpus Christi. By early April it is believed that the Trans-Florida pipeline will be in operation from Carrabelle to Jacksonville. This line has a capacity of 30 to 35 thousand barrels daily and will provide an efficient means of carrying light petroleum products across the Florida peninsula to Jacksonville from which port they can be barged north or south on the Atlantic Intracoastal Waterway.

The real life-line of the inland waterways is the great Mississippi River system, which offers excellent navigation from New Orleans to the "Twin Cities" of St. Paul and Minneapolis.

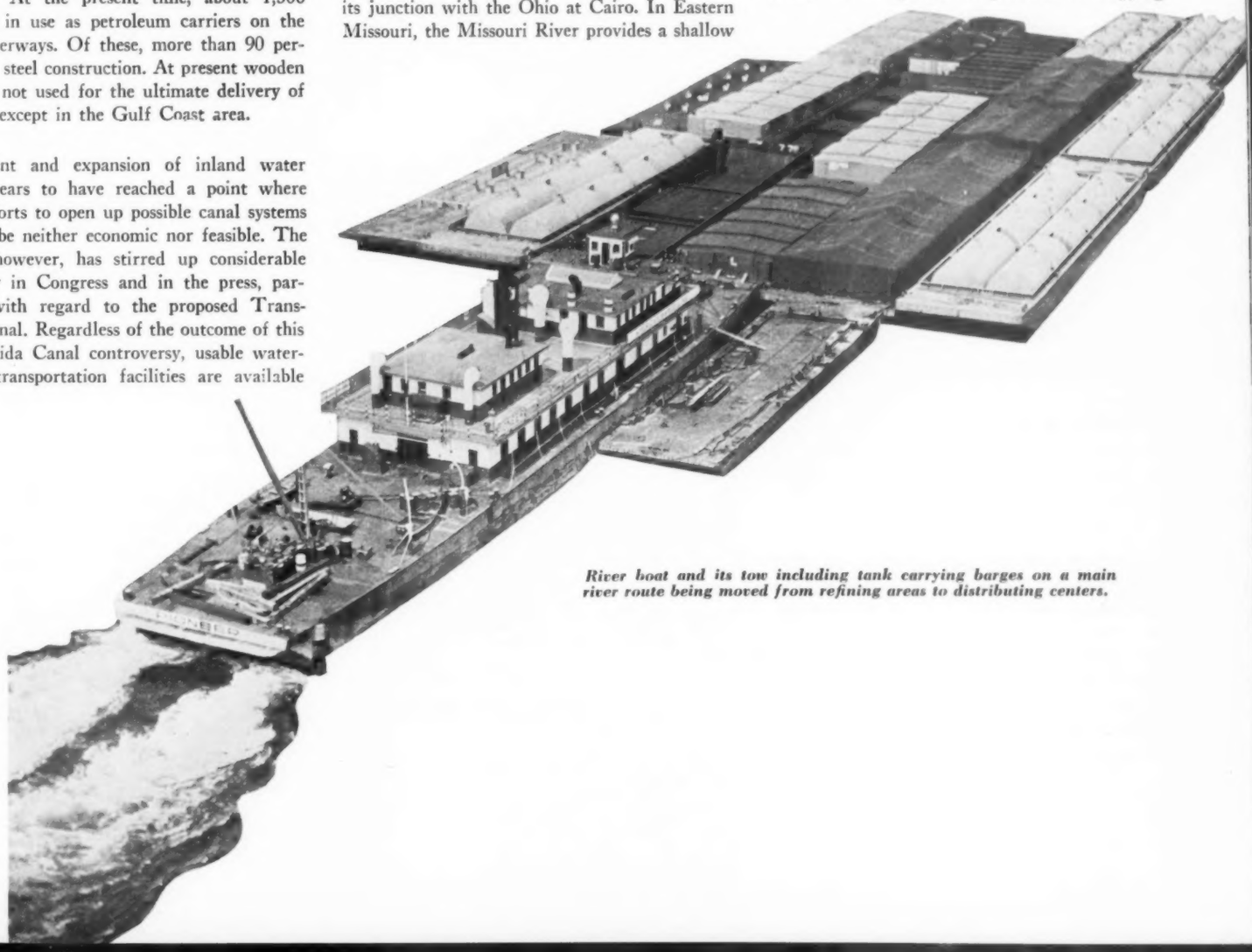
Through confluence with its principal tributaries, the Ohio, the Illinois and the Missouri Rivers, this mighty system serves a major portion of the Middle West.

The most important tributary of the Mississippi River is the Ohio which empties into the Mississippi at Cairo. Traffic reaches it after traveling from New Orleans up past Louisiana, Mississippi, Arkansas, Tennessee and Missouri. From Cairo, shipments are carried past Kentucky, Illinois and Indiana to Cincinnati, Ohio. Northeast of Cincinnati the Ohio River proceeds along the West Virginia-Ohio border to Pittsburgh.

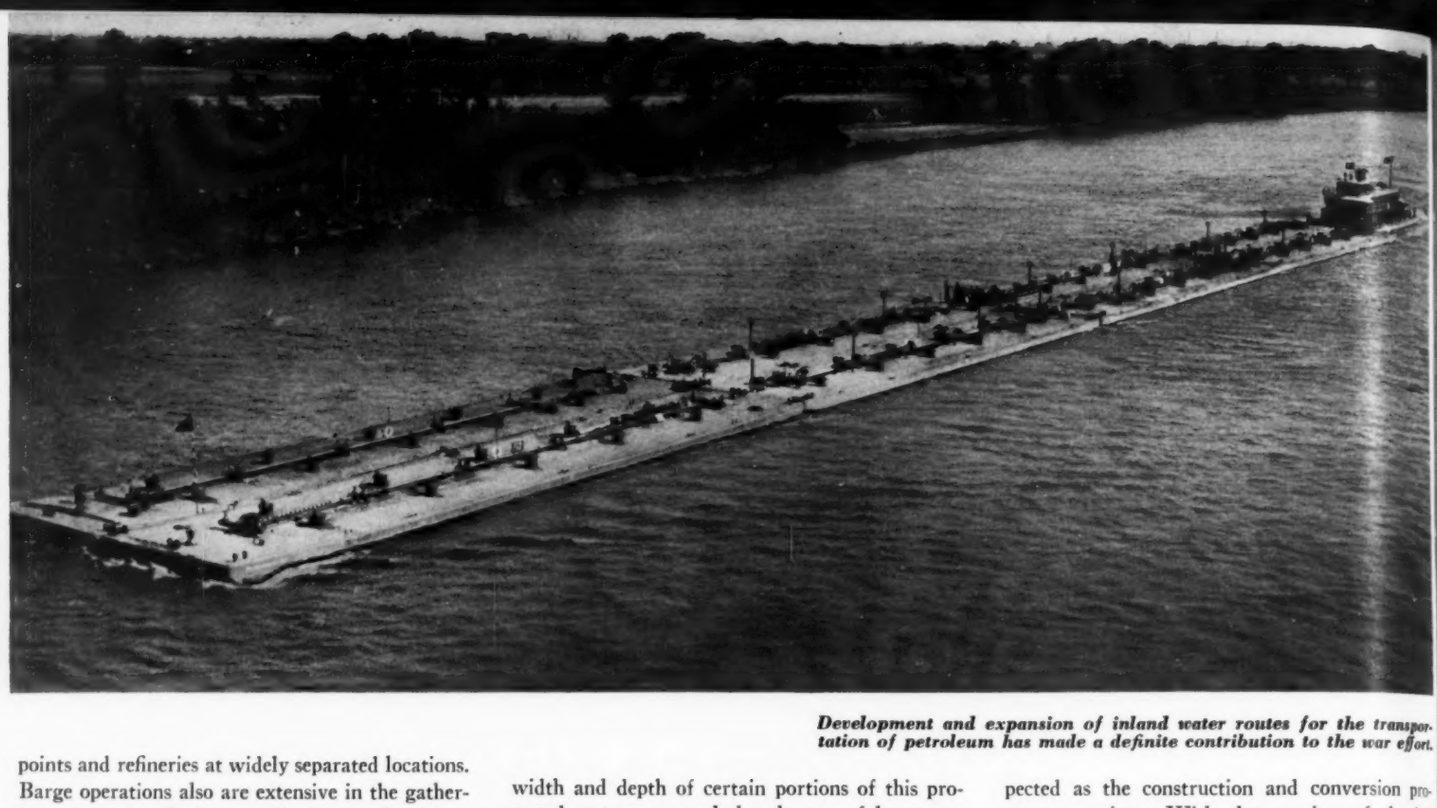
The Mississippi route continues northwest, above its junction with the Ohio at Cairo. In Eastern Missouri, the Missouri River provides a shallow waterway northwest into Kansas and Nebraska. From Alton, just above St. Louis, the Illinois River goes up through the state of Illinois, and is linked by a canal to Lake Michigan, at Chicago. The Mississippi above Alton follows the Missouri-Illinois border up past Iowa and Wisconsin, and reaches its northernmost navigable terminus at Minneapolis.

One of the most important inland waterway operations involves the transportation of petroleum products from the Chicago refining area through the Great Lakes to Buffalo. From Buffalo, barges carry these products through the New York State Barge Canal to Cohoes Landing, thence north or south by the Hudson River. A substantial amount of products so transported is transshipped from Renssalaer in tank cars for general distribution in the eastern part of District 1. The New York State Barge Canal is the most extensively used inland water route in the northeastern area.

The above paragraphs outline only the main arteries of the inland water routes, with no attempt to sketch in the many smaller rivers and tributaries contributing to the slow, but steady, course of barge-borne petroleum products from the great Gulf Coast and Midwest refining centers toward those areas where the demand for them is so great. Many southern rivers, including the Warrior, the Alabama, the Atchafalays, the Red and others, afford varying degrees of depths and facilities for the transportation of crude oil and petroleum products to shipping



River boat and its tow including tank carrying barges on a main river route being moved from refining areas to distributing centers.



Development and expansion of inland water routes for the transportation of petroleum has made a definite contribution to the war effort.

points and refineries at widely separated locations. Barge operations also are extensive in the gathering of crude oil from wells in the Louisiana bayou areas.

The Monongahela, Kanawha, Cumberland, Tennessee, and other rivers are important also to eastern deliveries of oil, with the Ohio River occupying the biggest role in moving finished products from points of origin on the Mississippi River to Louisville, Cincinnati and above. A pipe line brings refined products into Helena from the refining centers of the Upper Gulf Coast area, which are taken by barge to Minneapolis, to Cincinnati or, in some instances, as far as Pittsburgh.

First units of the fleet of 500 wooden barges which, together with 21 tow boats and 100 tug boats, are to swell the eastward movement of oil were launched late in March. The construction program is being directed by U. S. Army engineers and will be completed by the end of October. The boats will be operated by private companies under charter. The first of the boats to be finished will go into service along the Gulf and Atlantic coastal waterways. Others will be assigned to interior routes. Altogether they are intended to move 100,000 barrels of residual fuel oil daily along routes leading toward the East. Meanwhile, steady progress is being made in converting steel barges to use in oil transportation along coastal and river routes. Twenty-five of these out of a total of 122 acquired to date were in operation at the end of March.

Use of the Atlantic Intracoastal Waterway in supplying petroleum products to District 1 is a matter of great interest to those in Washington. From Jacksonville to Norfolk, this route has been proven of some use in moving petroleum products, although navigating conditions above Norfolk, leading to Baltimore and Trenton, are not particularly adapted to large movements by shallow draft inland waterway equipment. The width and depth of certain portions of this protected waterway precludes the use of large vessels. Slow-moving barges cannot operate with high efficiency because of the operating delays encountered.

The manpower situation ranks as one of the acute problems faced by officials in charge of developing the oil barge program. Selective Service has made great inroads on the supply of young men who have spent their lives in river operations and who would be well suited to pilot tugs and towboats on the inland waterways. Many men normally employed in inland waterway transportation have joined the Coast Guard. This dearth of pilots, engineers and unlicensed personnel is considered a chief bottle-neck in the barge expansion program. Shortages of barges, tugs and towboats still plague officials in charge of the barge program but, with the limited supply of steel and other materials available, the program is progressing as satisfactorily as can be expected. Engines in limited quantities for the tugs and towboats now under construction will be available, it is hoped, by the time the barges are ready for use.

A substantial increase in daily movements of petroleum on the inland water routes can be expected as the construction and conversion programs continue. With the opening of the ice-locked Great Lakes, the flow of oil products through the New York State Barge Canal should increase the present 120,000 barrel movement per day by inland waterways to District 1 to a possible 200,000 barrels daily.

While it is one of the more controversial factors in the petroleum transportation program, the movement of petroleum products by barge has made a very definite contribution to the war effort. The complicated problem of diverting tank cars to points where they can be of the greatest help in supplying the shortage areas has largely been solved by the recruiting of barges in sections of the country where rivers and canals are available. The program at least makes certain the steady forward movement of large quantities of oil to points where they can be picked up more efficiently for rapid transportation to ultimate destination by the railroads and the trucking lines. Although admittedly the "horse and buggy" partner of the swifter modes of transportation, the barge program has been accepted both by government and industry as a vital unit in the effort to supply the military, industrial and civilian oil requirements of a nation at war.

The Sohian, an ultra modern addition to the river barge fleet.

MOTOR TRUCKS Play Important Part In WARTIME OIL TRANSPORTATION

Increased Use in Local Service Has Released 25,000 Tank Cars for Long Distance Hauling—Tire Problems and State Restrictions Still Hamper Full Efficiency.

THE STRUGGLE TO MAINTAIN the all-important feeder-system, in a manner that will allow the maximum transportation of petroleum products to areas where they are most needed, is shared in to a larger degree than is generally recognized by motor truck lines which have been enlarged to cover areas formerly served by railroad tank cars.

Some 25,000 tank cars have been released from short haul service by building up truck transportation, from its pre-war status of local distribution and "errand boy" in the Eastern tanker terminal areas, to a major factor in the servicing of the North Central States.

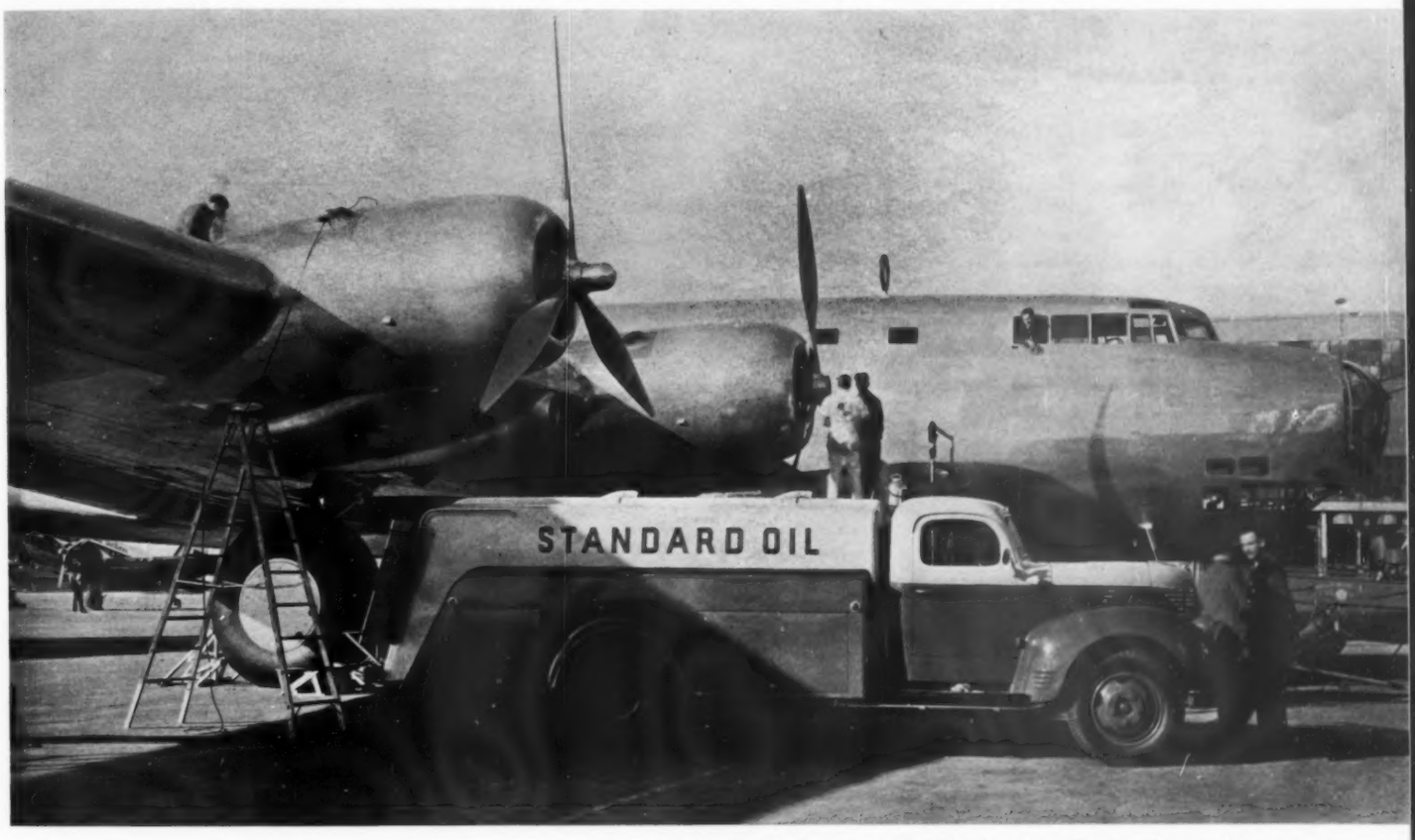
The advantage of replacing railroad equipment with motor trucks, wherever distances are short enough to permit, is recognized by the Office of Defense Transportation, the Petroleum Administration for War and other agencies concerned with the problem of moving petroleum products in a country badly crippled by the loss of its ocean-going tanker service. For this reason, the government is seeking to expand and improve a mode of transportation formerly used in purely local distributing operations.

A construction program, drawn up by PAW and ODT, and authorized by the War Production Board, placed 892 new units in operation this year. An additional construction program, covering 200 "special size" units, has been approved. Huge truck "trains," with a capacity of as much as 12,000 gallons, are little known in the East. In the Great Lakes area, however, these three-unit trucks hauled by tractor, are a familiar sight. They are used in Michigan, Ohio, and in the Chicago refining area and, to some extent, on the West Coast. Tank trucks of smaller capacity are used throughout the country for local distribution and interstate commerce.

The transportation of petroleum by motor trucks poses many problems not encountered by other carriers. Wide differences between state laws governing the operation of motor vehicles; the difficulty of obtaining replacement parts, on which the Army and Navy have priorities, and the acute rubber situation have seriously endangered the prospects of maintaining steady truck service for next winter.

According to John Arch Turner, chief of the motor transport section of PAW, there are now in service approximately 12,500 trucks of transport capacity (3,500 to 10,000 gallons), with an additional 110,000 petroleum trucks of from 900 to 3,500 gallons capacity on the roads. The January-February building program placed 892 units of 4,200-gallon capacity in service.

The new "special size" program, embracing 200 units, is largely devoted to trucks needed for



Motor truck shown refueling Douglas Army Bomber has a rated capacity of 1½-tons and the tank body holds 1,115 gallons of gasoline.

Fuel oil truck plowing its way through snow drifts getting oil to the rationed homes in New York and New England.

particular purposes. Thirty "trains" of 8,000-gallon capacity, have been requested for the Michigan, Ohio and Chicago-St. Louis metropolitan area, and 35 units of 6,800-gallon capacity are wanted for the West Coast.

An important part of the new program is the construction of 30 butane-propane trucks, with an 1.p.g. (liquified petroleum gases) capacity of from 3,000 to 4,000 gallons. These trucks, built of pressure steel and costing from $10,000 to $11,000 each, are needed in New Mexico, Texas, St. Louis, Chicago and the Bayonne-New York City metropolitan area.

With the Army using butane installations for cooking purposes throughout the southwest, and with the new demand for pressure-type trucks in areas where synthetic rubber and 100 octane gasoline are being manufactured, these new models will be in great demand. Factors limiting their use are their cost and their restricted field of operation. The balance of the 200-unit program will be made up of miscellaneous-size units with a capacity of from 2,500 to 6,000 gallons.

One of the greatest bottlenecks in the government's program to increase the transportation of oil products by motor truck is, naturally, rubber. Assuming that each set of heavy-duty tires is good for 40,000 miles, more than 3,000,000 tires a year are necessary to keep the petroleum tank trucks rolling. Army needs cut deeply into the present and estimated supplies of heavy-duty tires.

Replacement parts for the giant petroleum-hauling trucks are getting to be another worry, transportation officials admit. Axles, crankshafts, transmission parts and other vital automotive machinery are being used in Army mechanized equipment to such an extent that they are extremely hard to find for commercial use, particularly for the type of heavy vehicle used in petroleum transportation.

In the past the opposition of the railroads to extension of motor truck hauls beyond local areas and legal obstacles to the coordination of pipe line and truck transport have prevented the utilization of this branch of service with full efficiency. In many cases state laws and regulations restricting motor truck loads and operations were attributed to railroad influence and the relations between the two interests were far from cooperative. Before Pearl Harbor, a leading pipe transportation system in the Middle West never permitted motor trucks to service the terminals along its route. The reason for this was that the pipe line, being a common carrier, could not interline with any other non-common carrier. This situation, however, has been taken care of by application on the part of truck lines to state and federal commissions.

Called upon to put all available tank cars into service to the eastern shortage areas, the oil companies shipping through the Great Lakes Pipe Line terminals were required under ODT Order No. 7 to institute motor transport operation. The pipe line area, where oil products once had to be carried by tank car, or not at all, now is serviced almost completely by tank trucks. The advent of the war has had a softening effect upon the long-term opposition which truck operators have always received from the railroads.

Still another difficult problem in the truck movement of petroleum products is posed by the tire regulations set up by the Office of Price Administration. With the matter of determining which carriers are "essential" left up to local OPA boards, the petroleum trucks too often find themselves sidetracked in favor of farm trucks, grocery trucks and other vehicles also requiring rubber replacements. This situation has been temporarily taken care of by extra-large awards of tires to the lcoal board by OPA, in January and February, when public criticism was becoming vociferous. This, however, is a false abundance as probably will be revealed when these supplies are exhausted, and tire shortages may cause additional hardships unless the synthetic rubber program exceeds present expectations.

To be fair to OPA, it must be stated that the price agency recently has been seeing to it that petroleum trucks are not allowed to stay idle because of a scarcity of tires. State quotas, and the national quota, have been drawn upon, but the possibility remains that the supply may run short after a few months.

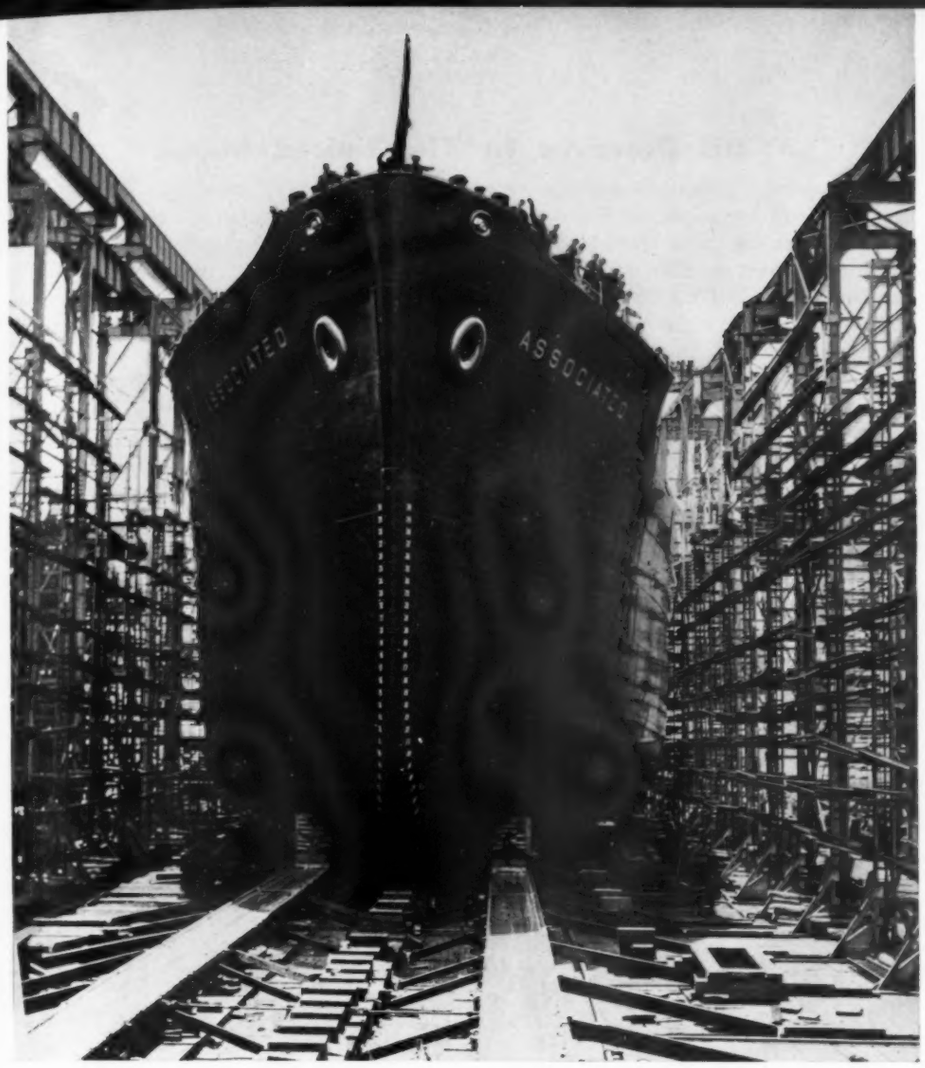
Another worrisome factor in the tire situation for drivers of petroleum tank trucks, is that recapped tires and retreads cannot be used satisfactorily. The great, heavy-duty tires sometimes 10 or more in service on a single truck, must be of high grade material if the average 40,000 miles of service is to be achieved. The ODT's Order No. 23, relaxing the 35 m.p.h. speed-limit on the heavy petroleum trucks which are geared to certain efficient speeds, is expected to help materially in saving the wear on tires and the use of gasoline.

While officials in charge of the motor transportation program have much to be concerned about when they contemplate the condition of trucks and tires for the winter of 1943-1944, plans to expand the present motor transportation program are being worked out daily. In addition to the completed construction program and the proposed 200-unit program, approximately 10 percent of the present 12,500 large trucks now in service are to be built annually to replace worn-out equipment.

With their principal job to relieve railroad tank cars for use in shortage areas, petroleum trucks rate high with government and oil industry officials who are figuring ways and means of furnishing the East with as much fuel oil and gasoline as can be assembled before another winter.

Careful scheduling and strict attention to the physical condition of trucks and tires have permitted the normal pre-war operation of tank trucks to climb from 10 hours a day to a 'round-the-clock service. In this respect, the problem of man-power shortage is seriously felt. Qualified drivers are hard to find for the long hauls now being performed by petroleum tank trucks, since the younger men, with steady nerves and stalwart constitutions, are being taken daily by the Army.

A capable member of the fast growing fuel motor truck fleet.



A new member of America's large tanker fleet shown on the ways prior to launching.

ENLARGED TANKER PROGRAM Supports War Operations

By a tremendous effort the place formerly occupied by the great American tanker fleet in moving oil to the Atlantic Seaboard has been filled, or nearly so, for the time being. But in reviewing the changes that have taken place in oil transport within the past year or more, it would be highly inappropriate not to refer to the vital and danger-filled part that the tankers are still playing, mostly beyond the borders of the country now, in keeping the planes and ships and land fighting machines of the United Nations in effective operation against the enemy.

Because of the supreme importance that oil occupies in war operations, information as to tankers now in service must be classified under the heading of military information.

While many submarines have made oil carrying ships their special prey and have accounted for an unannounced number of pre-war tankers, the oil fleet is growing in size and efficiency. Some tankers are operating coastally, but most of the oil they carry is earmarked for military purposes and only a trickle of tanker transported oil—quoted at between 25,000 and 50,000 barrels daily during 1942—reaches civilians.

The importance of oil to American military operations abroad, has had a significant effect on tanker construction. Where the pre-war tanker averaged from 9,000 to 12,000 deadweight tons, with a capacity of from 75,000 to 80,000 barrels, the Maritime Commission today is superintending a building program for much larger vessels. Two types of tankers make up the 258-vessel construction program now under way. While no break-down can be given concerning the respective number of each type, the program is divided between 18,000-ton vessels and a slightly smaller 16,000-ton design.

Sixty-two of the ships were built last year. It is expected, however, that the program will be considerably accelerated in 1943, in line with the strides that are being taken in the general merchant ship construction program. Five tankers were completed in January of this year, and nine in February. The new 18,000-ton tankers are 553 feet overall, with a capacity of 133,000 barrels. Speed and propulsion cannot be mentioned, but it is safe to assume that improvements in the size of the ships have been extended to their operation.

The Commission's concrete barge program (undertaken with understandable reluctance), provides for approximately 65 oil-carrying barges out of the 115 vessels on order. Forty-three will be 366-foot barges, with a 39,000 barrel capacity, and the other 22 will be larger, or approximately 370 feet in length, with a capacity of 44,000 barrels. Twenty-two large ocean-going tugs—157 feet overall—are under construction but it is not known whether they are being built in conjunction with the concrete barge program.

From the size of the new tankers, it is assumed they will be placed in service on routes where large deliveries of petroleum products are most urgently needed, namely, the theaters of operation abroad. The eventual use to which the concrete barges, on which construction has been much slower, will be put is still a matter of conjecture, although those who sponsor the "floating stones," as they are sometimes called, insist they are capable of trans-ocean crossings.

One of the most revealing statements on the "revolution in petroleum transportation" caused by the vanishing of the commercial tanker was given out recently by the Petroleum Industry War Council, in connection with the chart that appears as a supplement to this issue of WORLD PETROLEUM.

"The change from ocean tankers to tank cars, barges, and pipe lines is one of the most dramatic industrial revolutions imaginable," said William R. Boyd, Jr., chairman of the PIWC. "It is almost impossible to conceive the magnitude of the quantities of petroleum involved. Every day in 1941, on the average, we brought into the eastern area more than 1,500,000 barrels of petroleum and products, 95 percent by ocean tanker. This consumption, representative of pre-war conditions, is equivalent every two days to one gallon for every man, woman and child in the United States."

While total shipments have been only about 1,100,000 barrels daily, during the last few months, Mr. Boyd predicts that deliveries will be greater by the end of 1943 than they were before the war. He points out, however, that civilians will not get very much of the increased supplies and that the shortage next winter probably will be about as critical as it was this winter. The excess deliveries will be diverted to military needs.

A special tanker control board, comprising members of the Petroleum Administration for War, Army, Navy, War Shipping Administration and the British Petroleum Mission, supervises wartime tanker operations. Actual scheduling of the tankers is handled by the Navy and WSA.

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Oil Reserves In The United States

IN ITS ANNUAL REPORT the American Petroleum Institute's Committee on Petroleum Reserves estimates that, as of December 31, 1942, the proved reserves of crude oil in the United States amounted to 20,082,793,000 barrels, which is 493,497,000 barrels higher than its estimate as of December 31, 1941, when the amount of reserves was placed at 19,589,296,000 barrels. During 1942 the American petroleum industry produced 1,385,479,000 barrels of crude oil. Adding this figure to 493,497,000, it is seen that the total visible reserves have been increased during the year by the discovery of 1,878,978,000 barrels of new oil.

The Committee carefully explains the meaning of this statistical increase of 1,878,976,000 barrels of new oil. Reserves may increase in two ways. First, old oil pools may be extended by the drilling of more wells in the same field, thus revealing that the old pool contained more oil than was originally supposed when the field was first opened. Second, as a result of wildcat operations new pools may be discovered in territory not previously known to contain oil. The increase in total reserves therefore comes from an upward revision of the amount of oil known to be contained in old fields, plus the amount found in entirely new fields. The report shows the amount of oil found in entirely new pools discovered in 1942 was 260,051,000 barrels. The figures submitted by the Committee are shown in the accompanying Table I and II.

The Committee especially stresses the fact that its estimates of proved reserves do not reflect the availability, or rate at which these reserves can be produced with or without physical waste. For instance, dividing the amount of known reserves by an assumed rate of production, or any anticipated rate of consumption, may be misleading. Oil in the ground cannot be produced at an arbitrary rate for a given period of time. As a matter of fact, today's known oil can be recovered only over a period of gradually declining rates; this fact has been demonstrated by practical experience under all kinds of operating conditions.

TABLE I

Estimated Proved Petroleum Reserves in the United States
(in thousands of barrels)

	Proved Reserves as of January 1, 1942 (December 31, 1941) (1)	Proved New Reserves (Discoveries, Extensions and Revisions) in 1942* (2)	Production During 1942 (Bureau of Mines Preliminary) (3)	Proved Reserves as of December 31, 1942 (Cols. 1 & 2 less 3) (4)
Arkansas	295,017	31,637	26,628	300,026
California	3,323,147	121,025	248,326	3,195,846
Colorado	23,443	18,220	2,220	39,443
Illinois	333,714	79,520	106,456	306,778
Indiana	22,873	15,643	6,743	31,773
Kansas	689,795	94,816	97,636	686,975
Kentucky	36,450	2,675	4,472	34,653
Louisiana	1,330,134	227,718	115,726	1,442,126
Michigan	55,620	29,977	21,754	63,843
Mississippi	80,207	—10,477**	28,833	40,897
Montana	86,124	7,508	8,074	85,558
Nebraska	4,014	—600**	1,237	2,177
New Mexico	674,817	34,224	31,544	677,497
New York	59,816	none	5,421	54,395
Ohio	37,404	1,160	3,543	35,021
Oklahoma	1,035,820	73,797	140,690	968,927
Pennsylvania	170,897	none	17,779	153,118
Texas	10,975,641	1,053,457	483,371	11,545,727
West Virginia	50,011	750	3,574	47,187
Wyoming	304,053	97,911	31,392	370,572
Miscellaneous***	299	15	60	254
Total United States	19,589,296	1,878,976	1,385,479	20,082,793

* This column includes proved reserves discovered in new fields plus proved reserves added by extensions of pools only partly developed a year ago, plus or minus any revisions in former estimates. Only a limited area is assigned to each new discovery even though the Committee may believe that eventually a much larger area will produce, for in this report we are concerned only with actually proved reserves.
** No discoveries; previous estimates revised downward.
*** Includes Tennessee, Missouri, Utah and Virginia.

TABLE II

Summary of Committee's Annual Reports Covering Period 1937-1942
(in thousands of barrels)

	—NEW OIL BLOCKED OUT DURING YEAR—				
Year	Through Revisions of Previous Estimates and Extensions to Known Fields	Through New Pools Discovered During Year	Total Through New Discoveries, Extensions and Revisions	Production During Year	Estimated Proved Reserves as of End of Year
1936..					13,063,400
1937..	2,792,790	928,742	3,721,532	1,277,664	15,507,268
1938..	2,243,571	810,493	3,054,064	1,213,186	17,348,146
1939..	2,058,455	340,667	2,399,122	1,264,256	18,483,012
1940..	1,607,012	286,338	1,893,350	1,351,847	19,024,515
1941..	1,538,989	429,974	1,968,963	1,404,182	19,589,296
1942..	1,618,925	260,051	1,878,976	1,385,479	20,082,793

Cooperating with Uncle Sam

Four independent refiners joined together in 1931 to build the world's first cooperative Dubbs-cracking unit Its purpose was to crack the oils from their respective refineries to the best advantage of all Universal designed it It was enlarged in 1939

Now those refiners have taken a fifth party into their cooperative set-up—Uncle Sam He wants 100-octane gasoline—and lots of it

To make constituents of 100-octane gasoline the refiners are spending more than a million dollars converting the unit to catalytic cracking Universal refining specialists are on that job, too

Says Oil and Gas Journal:

> When conversion work is completed the cooperative cracking unit will supply charging stock to a government-owned plant now being constructed on adjoining property for the manufacture of 100-octane gasoline

That's the kind of cooperation going on throughout the refining industry today

OIL IS AMMUNITION—USE IT WISELY CARE FOR YOUR CAR FOR YOUR COUNTRY

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

THE REFINERS INSTITUTE OF PETROLEUM TECHNOLOGY

OIL SHIPMENT IN DRUMS

Drums of kerosene arriving to relieve New England fuel shortage. Photo Courtesy White Fuel Corp.

ABOUT THE MIDDLE of January, several railroad box cars loaded with metal drums left Southeastern Texas, bound for the East. In these drums was kerosene for the people of New England who depend on this oil for home heating and who were becoming alarmed over the rapidly diminishing supply. Thus began an unusual movement which, according to the Petroleum Administration for War, helped tremendously in preventing a serious fuel shortage. Within a week, the railroads were bringing into the New England states in box cars approximately 1,700 barrels of kerosene a day, and by the middle of February, the number of barrels had increased to 14,200 a day. Now the total is about 30,000 barrels a day or nearly three times the daily average of all petroleum and petroleum products which came into the Atlantic Seaboard areas by rail in the spring of 1941.

It was originally intended that the hauling of kerosene in box cars was to end in April, when the heating season would be over. However, the plan has been so successful that this method of shipping oil will continue as a supplement to the tank-car movement until the steel drums are no longer useable. Ordinarily a drum is not good for more than four or five such trips.

The idea of using metal drums to carry oil in box cars is not new. For years, drums have been employed to some extent for the transportation and distribution of lubricating oil, and they have been used extensively by the Army and the Navy. But this is the first time since the advent of the tank car and the tank ship that they have played such a big and important part in a commercial movement of this sort.

The box-car method of transporting petroleum is part of the plan to increase the flow of oil to the East to more than 900,000 barrels a day. At the present time, some 700,000 drums, nearly all of which were obtained from the Army, are assigned to this emergency service. Box-car shipments of oil to New England originate at Port Arthur, Houston, Texas City and Chaison, in Texas, and at North Baton Rouge and Chalmette, in Louisiana. At these points, the steel drums are filled with kerosene, and arranged in two tiers inside the cars. Normally, a box car will hold approximately 175 drums, each containing about 55 gallons of kerosene.

Unlike most of the tank-car movements to the Atlantic Seaboard, these shipments of kerosene do not usually move in solid blocks, but are parts of eastbound trains hauling other kinds of freight. They are consigned principally to the Boston area. On reaching their destinations, the drums are promptly removed from the cars and emptied into bulk storage tanks near the railroad terminal. The empty drums are then reloaded into the box cars, which return to the southwestern refineries for additional loads.

Various other methods of rail transportation designed to supplement the use of tank cars are being tested experimentally. One of these provides for fitting a standard steel box car with four tanks constructed of one-sixteenth inch sheet steel enclosed in wooden frames to hold them in position. The four tanks would have a capacity of 12,200 gallons or somewhat more than an ordinary tank car and the equipment of regulation freight cars to the transportation of petroleum products in this manner would require less steel than the building of new tank cars. Construction of a model car of this type was undertaken by the Baltimore & Ohio Railroad Company to determine its practicability.

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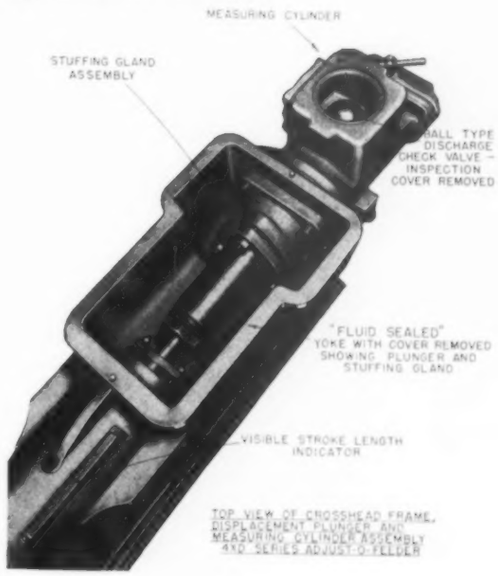
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Fig. 1

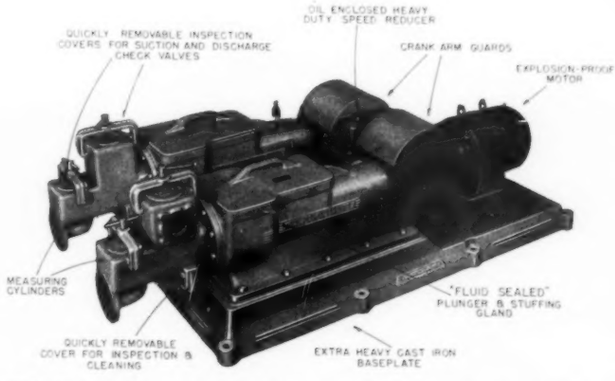
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Fig. 2

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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry—Edited by Dr. O. W. Willcox.

GEOPHYSICS

Geophysics in 1942—C. A. Heiland, in MINING & METALLURGY, Vol. 24, (1943), No. 434, pp. 73-76; 101.

Although geophysics as usual is out for the duration, various technical developments have been recorded in 1942. The gravimeter in its present form is approaching the limit of sensitivity, and the future aim will be reduction in size and weight. An integraph for evaluating effects of assumed subsurface features has been developed; also a torsion-balance simplification for measuring vertical and horizontal gradients at right angles to the strike. Magnetic prospecting shows little or no new instrumental developments, except one for measuring magnetic gradients. Electrical methods are being studied in the hope of finding a direct indication of subsurface oil. Seismic reflection mapping is being extended to more and more difficult areas heretofore considered unworkable with earlier apparatus; consequently, much attention has been given to freeing reflection records from undesirable interferences.

Geophysical well logging has seen fairly extensive activity in the past year. Heading the list of improvements is the Schlumberger self-potential dipmeter. A number of patents have been granted on logging through casing, and electrical logging by measuring magnetic currents between the drill stem and surface electrode. Other patents contain proposals to measure magnetic properties of strata by inductor measurements on cores, high pressure ionization chambers for well logging, and repeated radio-activity logging under different pressures.

Geochemical prospecting has branched out into microbiology. It appears that certain bacteria associated with oil may possibly be used as surface indicators of subsurface oil accumulation; soil samples are treated with certain reagents which produce typical color changes when hydrocarbon-consuming bacteria are present.

While low prices, manpower, material shortages, and other dislocations incident with the war have on the whole reduced geophysical exploration, this kind of work has increased in parts of the West, particularly the Dakotas, Nebraska, Wyoming, some of Colorado and Western Canada, and some previously unexplored territory has been entered in the South. Oil exploration by geophysics has increased in some South American countries, notably Argentina and Brazil.

Many geophysicists have gone into war work in various capacities. With more or less modification geophysical techniques to problems of detection by sound, electricity, and magnetism, and are therefore used for the location of guns, planes, submarines, land mines, sea mines, bombs, and for the defense of ships against magnetic mines. Not only are geophysicists actively contributing by observations and research to this work, but several geophysical companies are building the special equipment required, or are engaged in construction and development of apparatus for related fields, such as strain and vibration testing of airplanes and tanks.

DRILLING

Air-Drive Experiments on Long Horizontal Consolidated Cores—Harry Krutter and Robert J. Day, before AMERICAN INSTITUTE MINING METALLURGICAL ENGINEERS, New York Meeting, February, 1943.

The authors experimented with cores ranging from 20.9 to 132 inches in length and 1.80 to 3.66 inches in diameter. The sand itself was a fairly well rounded, well sized and moderately well sorted medium-grained sediment, and it was 100 percent saturated with oil. These cores were subjected to air drive with step-wise application of increasing pressure and with sustained high pressure. The results indicate that sustained high pressure gives a

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A complete index of the editorial contents of World Petroleum for the year 1942 has been prepared and will be mailed to subscribers on application. To conserve paper no general distribution will be undertaken but copies will be gladly supplied to those in a position to make use of them.

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DIFFICULT DRILLING PROBLEMS SOLVED WITH

MICATEX

One of the most difficult of all drilling problems is encountered in drilling through loose, creviced or fractured formations heavily charged with gas. Unless the drilling mud has adequate weight, the well may blow out. (See Fig. 1.) This weight which is necessary to hold the gas pressure may be great enough to cause loss of circulation in the permeable formation. (See Fig. 2.) Providing adequate mud weight to control pressures and not thereby lose circulation was an extremely difficult problem until MICATEX was introduced to the oil industry.

MICATEX seals the walls of the formation and helps prevent loss of circulation. (See Fig. 3.)

This ability of MICATEX to help prevent blowouts and lost circulation is proved in the following drilling problem encountered in the Gulf Coast. A well at 9447 feet struck a loose, high-pressured gas sand and attempted to blow out with a mud weight of 11.7 pounds per gallon (88 pounds per cubic foot). The mud weight was increased, but when it reached 12.2 pounds per gallon (91 pounds per cubic foot) circulation was lost. The well was shut in and MICATEX was added at the rate of 5 pounds per barrel to a pit of mud weighing 12.5 pounds per gallon (94 pounds per cubic foot). This mud was then pumped into the hole, and indications showed that circulation was re-established soon after the MICATEX-mud left the drill pipe. Weight was then raised to 13.8 pounds per gallon (103 pounds per cubic foot) with no further loss of mud.

The well was drilled to 9651 feet with no additional trouble. At this point casing was run and the operators reported that the well "was so satisfactorily walled-off that the pipe didn't touch a thing." During the cementing operation full mud returns were obtained the whole time the 16-pound-per-gallon slurry was being run, further indicating the ability of MICATEX to provide an effective mud seal and a clean hole.

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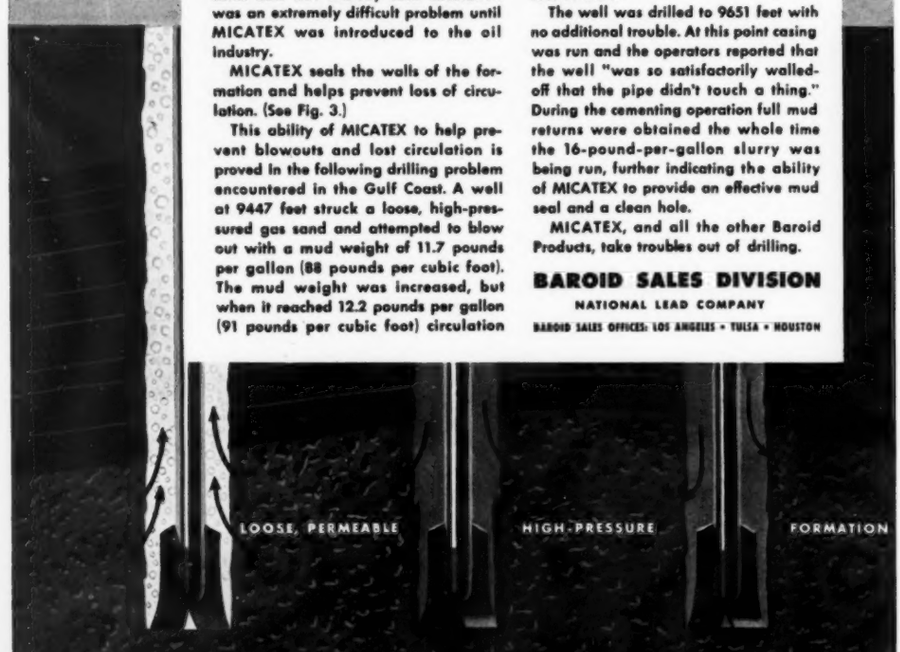

Fig. 1. Fig. 2. Fig. 3.

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1.28-fold recovery of oil as compared with stepwise pressure. The experiments show that the ultimate recovery is the same, within a few percent, whether air or methane is used for driving.

Among the problems considered by the authors is whether water flooding or air or gas drive should be used in a secondary-recovery operation. Another is whether an air drive project can be followed by a water-flooding project; also, if a property is considered to be a good water-flooding possibility, which will recover the more oil: straight water-flooding or air drive followed by water-flooding? In these experiments, by using a water drive after completion of an air drive, the total recovery was 85.6 percent of the original oil in the core. This recovery is considered indeed remarkable and opens up the possibility of water drive following air drive. The same core, subjected to water drive alone, resulted in a recovery of 65 percent of the original oil content. The experiments indicate that air followed by water is more efficient than straight water drive, and while the authors do not venture to draw general conclusions on this basis alone, it is evident that the point will bear further investigation, especially in view of the fact that connote water may quantitatively affect the result; this point awaits clearing up. The recovery by air drive depends on the pressure gradient; the higher the pressure the greater the recovery until an optimum pressure is reached, after which no appreciable gain in recovery is obtained with further increase in pressure.

PIPE LINES

Wrought Iron for Underground Services—Bulletin of A. M. Byers Co., issued 1943; 36 pages.

This publication contains a general discussion of wrought iron for underground pipe service, and considerable space is devoted to the use of this material for oil and gas wells, oil lines, gasoline lines and gas lines. The publishers state that while they manufacture a variety of wrought iron carbon steel, and alloy-steel products and are not unmindful of the merits of each, any attempt to prove that one material is superior to another, under all service conditions, would be contrary to good engineering. It is from that standpoint that experience with wrought iron pipe in the petroleum industry is surveyed, particularly in connection with underground applications.

In a west Texas oil field hydrogen sulfide corrosion was encountered and 3,100 ft. of upset steel tubing was installed; after 213 days of service the entire string had to be replaced. An identical string of upset black iron tubing was then installed and lasted 1,860 days.

Reference is made to an extensive series of records kept by a producer in the Gulf Coast area; 144 strings of wrought iron tubing, in comparison with steel, showed a ratio of useful life of 2.12 to 1. A compilation made by this company's engineers indicated a net saving of over $200,000 as a result of the substitution.

In one well afflicted with salt water near Eldorado, Kansas, steel tubing lasted 30 to 60 days. Galvanized wrought iron lasted 157 days, showing a ratio of service life between 2 and 3. Another company in the same field had 11 failures in steel tubing in 20½ months, all near the bottom. A string of 2" black wrought iron tubing in the bottom of the same well lasted 13 months before the first failure, and in 24 months only one additional failure oc-

curred. The savings were obviously considerable, even allowing for the higher cost of the wrought iron.

Another service record was compiled by an oil company in Arkansas. After 15 months in a new well seamless steel tubing had to be scrapped. Galvanized iron tubing was put in and remained for 12 months; when this well was abandoned the wrought iron tubing gave two years more of service in another well.

In a Pennsylvania oil and gas well wrought iron tubing is credited with a service life of more than 53 years. In another Pennsylvania gas well wrought iron tubing was pulled after 40 years, cleaned, and run back into the well without even rethreading.

A list is given of gas companies that are using wrought iron pipe because of its ability to withstand soil corrosion. A 16-inch line of the Pittsburgh and West Virginia Gas Company from Central to Littleton, W. Va., is regarded as typical; it was laid in 1935, was taken up in 1932 to replace out-moded couplings that had begun to develop leaks, was relaid in the same trench and is still considered one of the most reliable lines in the system. An 8-inch wrought iron gas line in Kentucky was taken up for relocation after 50 years; no leaks could be found. A parallel steel line laid when the first one was 26 years old has already failed. A 12-year soil corrosion test by the Gas Service Co. of Kansas City showed marked superiority of galvanized wrought iron over steel coated with a variety of non-metallic coatings.

Various other examples of the same tenor are cited.

Preventing the Corrosion of Iron Pipes—A. Wachter and S. S. Smith, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 35 (1943), No. 3, pp. 358-367.

Practically every long pipe line has had to contend with internal corrosion which produces scale and blisters of corrosion products, extending in some degree of severity through the entire length of the steel line. The important results have been decrease of throughput capacity and increase of operating costs for a line. Other, usually less important, results are deterioration or contamination of the refined products and loss in thickness of pipe wall. The steps taken to counteract these adverse effects have been chiefly palliative, although some attempts have been made to apply preventive measures. None of the preventive measures thus far proposed appear to have had success.

A study of this problem was undertaken at the Emeryville Laboratories of Shell Development Company in cooperation with the Products Pipe Line Department of Shell Oil Company, Inc. The most attractive possibilities were offered by sodium nitrite as a corrosion inhibitor. It was tested in part of a Shell products line with encouraging results. Extension of the treatment was gradually made until it was being applied to all of the products lines operated by Shell Oil Company. After two years of use, the inhibitor and its method of application have provided a complete and economical solution of the problem of internal corrosion of products pipe lines.

In all, it has been used successfully in more than 800 miles of pipeline for refined oil products. The use of mechanical scraping measures for the removal of old rust scale while injecting sodium nitrite continuously into an old line has been shown to achieve a non-rusting line with a flow factor at least equal to that assumed for a new pipe.

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The sodium nitrite has been found to have no adverse effect on the quality of the refined products that may be pumped through the line. The work here reported indicates that a solution of 0.1 percent sodium nitrite prevents rusting at a gasoline-water ratio of at least 200,000 to 1, and that the protection of the steel will persist for a time after injection of nitrite has been stopped.

The action is supposed to be somewhat as follows: the sodium nitrite forms a protective film on steel which is capable of withstanding small amounts of uninhibited water for a limited time.

BOOK

Stratigraphy of the Eastern and Central United States—By Charles Schuchert. Published 1943 by JOHN WILEY AND SONS, New York, 1,013 pages, 6 x 9, 4 plates, 123 figures; $15.00.

This is volume II of a monumental work under the general title of Historical Geology of North America; volume I is the Historical Geology of the Antillean-Caribbean Region; Vol. III, still in preparation, will deal with the stratigraphy of Greater Acadia, Canada, Arctic Archipelago and Greenland.

The present volume is limited to 30 states (including Texas) of the eastern and central United States. The formations dealt with are mainly the Paleozoic, although a good deal of the Mesozoic and Cenozoic marine history of the Atlantic-coastal plain is also presented. The Gulf Coastal is covered by the previously published Vol. I. The widely exposed marine Mesozoic formations of the Western port of the Central States are described but those of the Cenozoic are given little attention. The book is essentially a text book for students and at the same time a compendious reference book for mature geologists. Much prominence is given to the geology of New York State and Appalachia as it was here that the foundations were laid for American geology and where the core of American geological terminology was developed.

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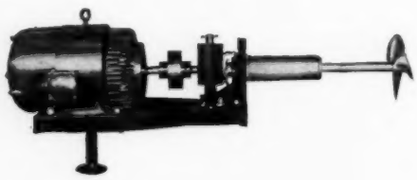

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GENERAL

Geochemistry's Place in Future Exploration—Robert O. Smith, in WORLD PETROLEUM, Vol. 13 (1943), No. 3, pp. 45-47; 49.

In the first place, it is apparent that geochemistry must be called on to do what it can to locate stratigraphic traps which now elude detection by both geophysics and geological studies. There is probably three times as much oil impounded in stratigraphic traps as has ever been found in anticlinal areas; and now that many if not most of the anticlines have been located by the geophysicists, future discoveries must come from detecting the presence of the traps which neither the geologist nor the geophysicist can find.

Geochemistry as an oil-finding art has to meet and overcome three principal sources of confusion in interpreting its results. One is that the hydrocarbons that appear in the soil above the petroleum deposit are chemically not very reactive; however, at the cost of much experimentation this difficulty has been overcome. A second difficulty is the tendency of certain strata (chiefly limes) that are near source beds to present non-commercial or "fake" showings of oil. This has been counteracted to a considerable extent by a discovery that made it possible to tell whether the oil indications originated from lime strata or sand strata. A third difficulty in shifting of apparent structure with depth, which may cause indications of oil to appear at the surface far from the real location of the oil deposit. However, much has been learned about how to unravel this source of confusion.

Although still beset by these difficulties, geochemistry has given a much better account of itself than might have been inferred from its early experience. Although it has had some notable successes, most of the disappointments have resulted from small and inadequate surveys, but where adequate surveys have been made it is estimated that four wells have come in out of every ten recommended. In Southern Louisiana, where the oil men are thoroughly cognizant of the necessity of doing thorough geophysical surveys, it is definitely known that every other wildcat drilled on geochemical surveys is producing oil.

In any case, with the increasing scarcity of preferred structures, the oil industry must follow one of two courses. It must look to virgin districts for geophysical operations, or find stratigraphic traps in new or old regions. In such a hunt geochemistry, correctly applied, will find a most difficult place.